

The Values of Philippine Coastal Resources:

Why Protection and Management are Critical



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Coastal Resource Management Project
of the
Department of Environment and Natural Resources
supported by the
United States Agency for International Development

Cebu City, Philippines

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by

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1998

Printed in Cebu City, Philippines

Citation:

White, A.T. and A. Cruz-Trinidad. 1998. The Values of Philippine Coastal Resources: Why Protection and Management are Critical. Coastal Resource Management Project, Cebu City, Philippines, 96 p.

This publication was made possible through support provided by the United States Agency for International Development (USAID) under the terms and conditions of Contract No. AID-492-0444-C-00-60028-00. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the USAID. This publication may be reproduced or quoted in other publications as long as proper reference is made to the source.

Captions:

Front cover: Sarangani Bay (left); Diverse coral reef, Tubbataha Reef, Sulu Sea (top right); Surgeon fish, Bastera Reef, Sulu Sea (bottom right). Back cover: Old mangrove trees, Sarangani Bay (left), Fusilier fish, Tubbataha Reef, Sulu Sea (right). Photos by: A.T. White

CRMP Document No. 37-CRM/1998

ISBN 971-91925-3-4

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List of Abbreviations

BFAR	– Bureau of Fisheries and Aquatic Resources
EWDS	– environmental waste disposal services
GDP	– gross domestic product
GVA	– gross value added
gt	– gross tons
ha	– hectare
hp	– horsepower
ICM	– integrated coastal management
kg	– kilogram(s)
km	– kilometer(s)
km ²	– square kilometer(s)
m	– meter(s)
m ³	– cubic meter(s)
MER	– maximum economic rent
MEY	– maximum economic yield
MSY	– maximum sustainable yield
OAE	– open-access equilibrium
OAY	– open-access yield
POPs	– persistent organic pollutants
t	– tons (1,000 kg)
TEV	– total economic value
WTP	– willingness-to-pay

Acknowledgments

The compilation of this book depended on much information derived from a variety of sources in and outside of the Philippines. Several resource economists and others who deserve special mention for their research and ideas include: Herman Cesar, John Dixon and Louise Fallon-Scura of the World Bank; Marian de los Angeles, Jose Padilla and Rina Rosales of the Environment and Natural Resources Accounting Project, Philippines; and Tijen Arin of Duke University. Several natural scientists who have provided key information in recent years include: Angel Alcala, Eduardo Gomez, Perry Aliño, John McManus, Daniel Pauly, Garry Russ, Gregor Hodgson and Peter Vogt. Tito Rodriguez is thanked for his research on the earliest stage of this book.

Those associated with the Coastal Resource Management Project who have contributed to this book include: Catherine A. Courtney, Benjamin Francisco, Tom Bayer, Dolores Ariadne D. Diamante-Fabunan and Leo Pura. Review comments by Marian de los Angeles; Mahfuz Ahmed of the International Center for Living Aquatic Resources Management; Catherine Courtney and Tom Bayer; and Dianne Antoinette Parras of the University of Miami School of Marine Affairs have provided helpful improvements. We are also grateful to Rose Yabut of the International Center for Living Aquatic Resources Management Library for helping us with the references. Copy editing was done by Leticia Dizon and Tom Bayer and design and layout were done by Melvin Teoxon and Ysolde Collantes.

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Foreword

True Filipinos love the ocean.

For an archipelagic country like the Philippines, with a coastline of 18,000 km, this statement should be non-debatable. With an exclusive economic zone (EEZ) of 2,200,000 km², much of the country's territory and much of its development potential lie in its coastal and marine waters.

Yet the importance and potential of our coastal and marine ecosystem have been unappreciated. Their conservation has been neglected. As a result, we find the phenomenon of poverty amidst wealth in the cities, municipalities and barangays of our coastal areas. In a very short time we could find ourselves in a situation of increasing poverty as the vicious cycle of poverty and environmental degradation proceeds at an alarming pace.

It is thus a great relief that the Coastal Resource Management Project (CRMP), a technical assistance project of the United States government to the Philippines and implemented by the Department of Environment and Natural Resources (DENR) is addressing coastal management issues in the Philippines. Supported by the project are two leaders of the conservation movement who bring understanding to the importance and potential of our coastal and marine waters to the larger public. The difference of their chosen professions, Dr. Alan White being a marine scientist and geographer and Annabelle Cruz-Trinidad being an economist, further strengthens their effort as the elements of science and of institutions are brought together as they should.

What they have produced is a book that goes beyond the biology of coral reefs, mangroves and fisheries. What we finally get is truly the answer to the question, "Why are protection and management of the coastal and marine resources critical?" For those who need to be convinced as well as those who will do the convincing, this is the book for them.

As always, when we see good work and good people, we say “may their tribe increase!” Indeed in a short time, it is expected that their work will produce the critical mass of Filipinos that are not only committed but also well-informed advocates of marine conservation. The political will so necessary to shift from today’s destructive exploitation to one of sustainable development would then be generated.

There is hope yet for our coastal and marine resources-but this ultimately depends on all of us.

Read this book, *love the ocean, and be truly Filipino.*

DELFIN J. GANAPIN, JR., Ph.D.
Philippine Federation for
Environmental Concerns (PFEC)

Preface

This book has many uses in assisting the way we value our natural resources. It can serve as a reference for finding and citing information required to make informed decisions about when and how to protect and manage coastal resources in the Philippines and elsewhere. It can be used to convince ourselves and others about the need to plan and manage for the future. This book summarizes common valuation methods used and when they may be used appropriately. It describes in detail the values of coral reefs, mangroves, fisheries and water quality to Philippine society. Integrated coastal management and its associated costs and benefits are described as a means of solving some of the protection and management problems facing the Philippines and its tropical coastal resources. Other objectives are to:

- Provide information on the economic and other values of coastal habitats and ecosystems in terms of direct production, loss of earnings from destruction and values created by tourism, research and education uses as well as the mere existence of a natural resource;
- Show how the stream of benefits from a natural coastal ecosystem is basically free to people provided that ecological parameters are honored;
- Show what in aggregate is lost from destruction of these valuable ecosystems;
- Give an estimate of what is gained from management interventions such as marine reserves and sanctuaries which result in the stabilization of an ecosystem and the potential increase in direct production and other uses;
- Provide information on the cost of management interventions and possible sources of support; and

- Support policy makers in the often difficult decision to disapprove or disallow more intensive levels of exploitation of fisheries and other important uses.

This book is a reference to assist in managing our coastal resources. Relevant information can be accessed on resource valuation methods (Chapter 1), the valuation of uses of coral reefs (Chapter 2), the valuation of mangrove forests and habitats (Chapter 3), the valuation of fisheries to the Philippines (Chapter 4) and the valuation of water quality (Chapter 5). The economic justification for applying integrated forms of management to the problem of coastal degradation is presented in Chapter 6.

This book can become a creative tool in better understanding the natural environment upon which we depend. It is ironic that in a world increasingly controlled by a monetary economy of global scale, we generally do not know the real monetary worth of the basic natural resources upon which our global and local economies depend. This book will help remedy this problem by assisting us to value our immediate sources of subsistence and putting them in perspective with various options for development.

Chapter 1

Introduction: Values and valuation are the key

PHILIPPINE COASTAL RESOURCES—A STORY OF DEGRADATION

The coastal ecosystems of the Philippines are some of the most productive and biologically diverse in the world. The Philippines, as part of the Southeast Asian region, lies in a rich biogeographic area in which most higher taxa of shallow-water marine life reach the peak of their species diversity. This diversity is associated with high primary productivity and high fishery yields. The productivities of some tropical marine ecosystems are given in Table 1.1, which highlights the relative productivity of mangroves, seagrass beds, coral reefs, estuaries and upwelling zones. These systems are responsible for much of the fish catch and marine food production in the country and for many other economically important activities.

Table 1.1. Primary productivity of some major marine communities¹³¹.

Community type	Primary productivity (grams carbon/m ² /year)
Mangroves	430 - 5,000
Algal, seagrass beds	900 - 4,650
Coral reefs	1,800 - 4,200
Estuaries	200 - 4,000
Upwelling zones	400 - 3,650
Continental shelf waters	100 - 600
Open ocean	2 - 400

Coastal ecosystems in the Philippines and all over Southeast Asia are under severe stress from the combined impacts of human overexploitation, physical disturbance, pollution, sedimentation and general neglect^{26, 66}. Although this region is the tropical marine and coastal biodiversity center of the world, the decline of coral reef, seagrass, mangrove and estuarine quality and productivity is disturbing. Surveys in the 1980s and 1990s have shown that more

than 75% of the coral reefs in the country have been degraded from human activities (Table 1.2)^{26, 52, 53, 134}.

Table 1.2. Status of Philippine coral reefs based on surveys by three projects^{26, 52, 53, 134}.

Project sites	No. of transects (Station)	% living coral cover							
		Excellent (75-100%)		Good (50-74.9%)		Fair (25-49.9%)		Poor (0-24.9%)	
		No.	%	No.	%	No.	%	No.	%
Philippines ^a (various)	632	35	5.5	153	24.2	242	38.3	202	32.0
Philippines ^b (various)	103	4	3.9	32	31.1	46	44.7	21	20.4
Lingayen Gulf ^c 1988	40	0	0	18	45.0	17	42.5	5	12.5

^aUniversity of the Philippines Marine Science Institute (1985)

^bASEAN-Australia Living Coastal Resource Project

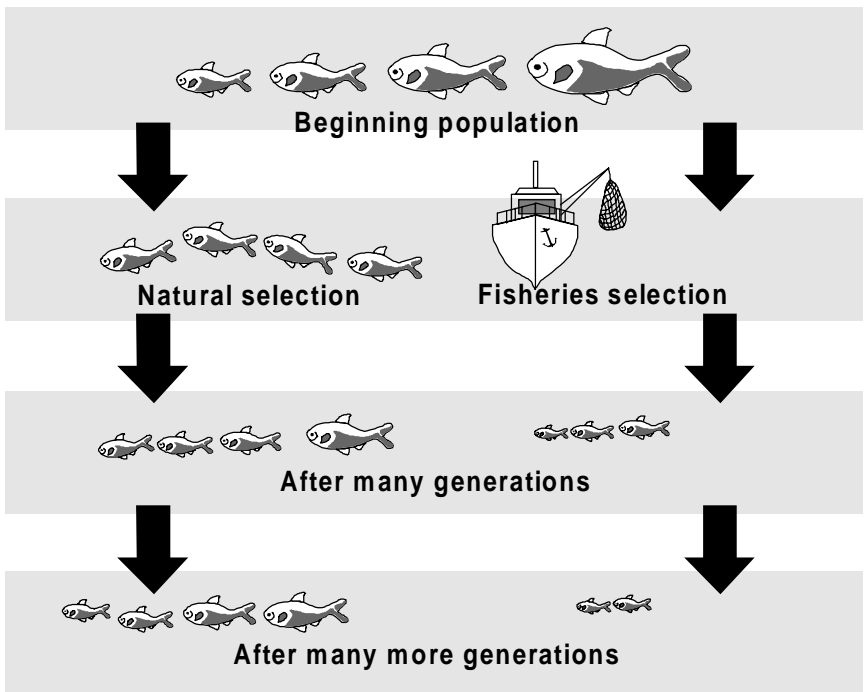
^cASEAN-US Coastal Resource Management Project

Mangrove resources are in no better condition than coral reefs in the Philippines. Since 1918, the mangrove cover in the country has declined from about 450,000 ha to less than 150,000 ha in 1988⁴⁰. The most rapid decrease occurred in the 1960s and 1970s when government policies encouraged the expansion of aquaculture during a period when real prices for fish and shrimp were steadily rising¹⁰¹. National laws prohibit the cutting of mangroves, except in specified management areas. Nevertheless, this ecosystem type continues to decline at a rate of approximately 2,000 to 3,000 ha/year¹²⁴.

Fisheries of all kinds in the Philippines are near or have surpassed sustainable levels of catch. Most studies show that all important fisheries are overfished and that the real return in terms of volume of catch and economic value is declining^{86, 87, 94}. In some cases where volume has increased, the catch composition has changed to a lower value of catch because of changes in the ecological make-up of the fishery. The causes are complex but the bottom line is that

fishing effort is greater than the resource can support, fishery recruitment is limited and habitats are degraded. Because catch per unit effort has decreased dramatically over the last fifty years, there are now fewer fish and a lowered reproductive capacity as shown in Figure 1.1.

Figure 1.1. Long-term impacts of overfishing will decrease the size and abundance of fish in the ocean¹⁹.



While recognizing the condition of coral reefs, mangroves and fisheries, it is important to highlight the commonality linking these systems together and also connecting them to land: water. Water and its transport role is crucial since pollution of all kinds can easily be carried by water to affect living coastal resources. We often assume that the absorption capacity of the ocean is unlimited but we now realize this is not true. As the sea becomes more polluted, living coastal resources will be lost at an increasing cost to society.

The most important factor linking the ecosystems together and the one that values their products and services as well as being responsible for their use and abuse is the human element. Humans have of course created the whole situation of overuse and degradation by not being sensitive to the ‘carrying capacity’ of both the local and global ecosystems of which we are a part. Coastal systems are particularly vulnerable to human abuse because more and more people are living, working and recreating in coastal areas. This highlights the need for limits to population growth if we want to manage our natural resources for the future.

WHY MANAGE OUR COASTAL RESOURCES?

The reason we must manage our coastal resources is that they are a huge natural and economic resource in the country in terms of food supply, livelihood, other revenue and quality of environment. Management, which implies wise use and maintenance of the resource, is crucial to ensure the continued productive stream of net benefits without inputs from humans. In other words, we can simply harvest and use fish, mangroves, clean water, beaches, estuaries, without any investment, so long as we do not damage the ecosystem or overexploit the natural production levels of each system and its products.

The problem in the Philippines and many other tropical countries, simply, is that we are damaging and overexploiting all the coastal ecosystems and their natural ability to produce to the point of doing permanent damage to the system. This means that in the future we will have much less resource left and its net natural productivity will be significantly reduced or there will be nothing left. An analogy would be letting termites eat the foundation of our house. At first the effects would not be too noticeable but one day it would collapse! This is also the case for fisheries—one day they may just disappear or at least decline significantly as seen in fisheries for lobsters, grouper, some species of tuna and others.

One way to encourage us all to improve our management, protection and support for these natural coastal ecosystems is to place economic values on their presence, products and uses. As a society,

we tend to value money and we understand costs and benefits in monetary terms. Thus, the information in this book is intended to portray the economic values of coastal resources so that we may place more importance on their management and long-term protection. This will hopefully improve our commitment and quality of response in managing these resources. It can also help us justify the investment required to manage our use and to control our abuse of coastal resources.

CONCEPT OF "VALUE" AND COASTAL RESOURCES

"Because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of humans in the biosphere."³⁵

Resource valuation is an essential component of sustainable development. To assess options for resource management, the decision maker needs to be provided with complete and accurate information on the potential impacts of these decisions. In the past, the traditional approach was to conduct financial and economic cost-benefit analysis of the "priced" goods and services. Natural resource inputs were ignored because scarcity was not an issue then and because of the difficulty of assigning values to these services and functions.

Resource valuation provides an interface between economics and the physical sciences such as ecology, engineering or agronomy. While the hard sciences provide the physical relationships, economics provides the concepts and methods behind the valuation process. This enables biophysical goods and services to be reduced to a common unit understood by all stakeholders: money.

It is necessary to understand the basic concepts of resource valuation, economic value and methods to conduct valuation. The valuation techniques presented here are based on the research of selected economists^{14, 43, 76}.

What is resource valuation?

Resource valuation is the process of assigning a measurable value, usually monetary, to a particular resource, product or activity. The valuation process uses a number of monetary valuation methods to account for use and non-use values of resource systems.

The valuation of natural resources is not the same as the valuation of ordinary goods and services. The value or worth of a particular good is equivalent to the price determined by the market based on supply and demand conditions. Natural resources such as forest and coastal resources can also be priced according to the market goods they produce. However, this value can only reflect the partial value of the resource because natural resources provide other and oftentimes, more significant values, on top of those already priced in the market. For example, forest resources are traditionally valued according to the amount of timber, logs or plywood produced and coral reefs are valued according to the quantity of fish caught. This is convenient because only timber, logs and fish are bought and sold in the market. What we have missed among other things is that forests and coral reefs provide services by minimizing the costs associated with coastal erosion. For example, forests stop floods by retaining water while coral reefs serve as buffers against wave action. In these cases, a cost avoided is a benefit. Some common “goods” and “services” of coral reefs and mangroves are shown in Table 1.3.

Biodiversity conservation is one of the most important benefits (services) attributed to coastal ecosystems in their natural state. Biodiversity in the broad sense is a driving force of marine conservation activities in the Philippines as indicated by the existence of the Philippine National Biodiversity Strategy and Action Plan and the International Convention on Biological Diversity. Biodiversity can be equated with the continued healthy existence of these valuable marine ecosystems. The associated biological resources provide food, medicine, chemicals and other products used by society. In addition to the already well known uses of these resources such as food, it is the still undiscovered uses such as for new medicines and their overall role in the continued viability of the system into the future which really make "biodiversity" so valuable to humans. An example is the ongoing research for anti-cancer chemicals from some coral reef

Table 1.3. Selected economically valuable “goods” and “services” of coral reefs and mangroves.

Ecosystem	Goods (Consumptive or direct use values)	Services (Non-consumptive or indirect use values)
Mangrove forest	Wood Fish Crustaceans Mollusks Medicinal products	Sediment sink Nutrients for fisheries Habitat Support roots Water filter Biodiversity
Coral reefs	Fish Crustaceans Mollusks Coral rock Marine plants	Recreation opportunities Coastal protection Research venue Education outlet Biodiversity

organisms. Thus, this benefit, although often difficult to value economically beyond the marketable products it produces, cannot be ignored in the valuation process for coastal resources.

Two procedures in measuring environmental costs and benefits are: (1) determining the physical impacts and relationships; and (2) valuing the benefits and impacts in monetary terms⁷⁶. The first establishes the impacts or potential impacts of a particular management option on the natural resource base. Management options cover the broad spectrum of resource use options from pure conservation to various forms of development. This procedure is usually performed by engineers, ecologists and other experts. Valuing the benefits and impacts economically requires economic analysis and skills and often entails discounting costs and benefits which will occur in the future so they can be measured in the present. Both are dealt with in this book.

What are the components of value?

Total economic value (TEV) consists of use and non-use values⁴⁴. Use value measures the consumptive value (direct use values) of tangible natural resources such as fish, timber, water, as

well as non-consumptive (indirect use values) ecological and recreational uses of natural resources such as diving, swimming, boating, bird-watching and picnicking (Figure 1.2). Use value consists of direct, which can be classified as “goods” and indirect use values, which can be classified as “services”.

Non-use (or vicarious) values may still be derived even if individuals do not use the resource directly. Existence value, which is also known as preservation value, may be denoted as the value to a human of knowing that a resource, that he or she never intends to consume, is protected. However, existence value is also frequently defined as option value (the value of natural resources for future generations) or bequeathment value (the value of endowing a natural resource to posterity). Option value is the willingness-to-pay (WTP) for the option of using/consuming the resource in the future. Option value also represents the willingness-to-pay for future use of yet undiscovered qualities such as medicinal use of a plant or marine organism.

Valuation efforts should attempt to aggregate both use and non-use values of natural resource systems to assess the total economic value as indicated in Figure 1.2.

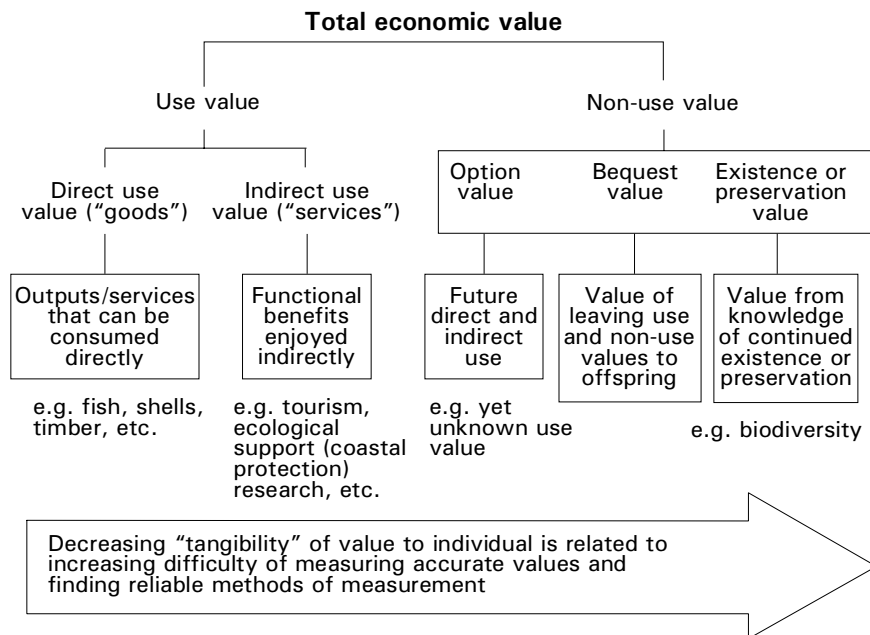
Valuation techniques

The common valuation techniques in use are few and only the most important are discussed below. The purpose of understanding these techniques is to know when they can be used appropriately. They are the means to finding the common denominator of value: money.

A. Conventional or direct valuation methods

Direct valuation methods are used when changes in production or productive capacity of a certain good or service can be measured. Here, willingness-to-pay is taken to be equal to market price. Surrogate prices and opportunity costs are used in lieu of market prices when non-competitive markets exist.

Figure 1.2. Types of resource values^{76, 104}.



- **Change in productivity** estimates changes in production arising from a particular intervention or natural resource state and is most often used for coastal resource valuation. We need "before" and "after" or "management versus no management" production estimates with the same parameters and assumptions used to measure the changes. The values captured are direct use values derived from extractive uses of outputs from the natural system. Most case studies on coral reef and mangrove valuation involving fisheries and wood production use this technique^{10, 25, 58, 64, 92, 100, 104}.
- **Loss of earnings** estimates foregone earnings arising due to morbidity or mortality associated with changes in environmental quality and is used in estimating impacts of pollution and industrial hazards. A direct dosage-

response relationship must be established between the pollutant and the human or environmental health problem for this method to be effective. This technique needs an assessment of the “before and after” scenarios and requires health care data as well as epidemiological studies.

- **Opportunity cost approach** estimates the costs of foregone development benefits as criteria for decision-making. It is most appropriate in evaluating conservation versus development options, i.e., large infrastructure projects which may require conversion of natural coastal systems. It requires estimating the non-use values associated with preservation of natural habitats. It uses a conventional cost-benefit analysis to determine net benefits of development options in relation to benefits of preservation. Various studies have used this method to illustrate the tradeoff between different development options^{16, 36, 46, 64}.
- **Actual defensive or preventive expenditures** measure the value people are prepared to spend on preventing damage to themselves or the environment. Examples are expenses incurred to avoid or reduce unwanted environmental impacts such as coastal erosion or water pollution. This approach provides only a minimum estimate of the value of environmental services, since it cannot be higher than an individual's ability and willingness-to-pay (WTP), which is usually constrained in developing countries¹³³.

B. Indirect or hedonic market methods

No market exists for most environmental goods and services. However, these commodities can be related to market commodities. Recently, resource economists have expanded the border of markets by estimating environmental functions and indirect economic goods using surrogate prices and by “constructing” hypothetical markets. This technique is often called surrogate price technique because the price of market commodities is “borrowed”. For example, potable water from an upland stream does not have a price but what can be used in the valuation process is the charge imposed by the utilities firm for water access and use. We can also value ecological benefits of

mangroves such as litter and flood prevention. For example, the “cost” of maintaining mangrove biodiversity can be estimated by determining fees students or tourists are willing to pay to study the site while the “cost” of litter and other organic matter can be taken as the price of shrimp feed. The tendency to incorporate “new” ecological attributes, such as biodiversity and energy values, has increased the total economic value of mangrove forests and other ecosystems.

- ♦ **Property value** measures to what extent real estate is affected by environmental quality parameters. The basic process is to compare the prices of houses in polluted areas with similar neighborhoods endowed with a better environmental quality so that we can determine price differentials attributed to environmental parameters. This approach has been applied to wetlands valuation in Florida fisheries¹⁵ and could be applied in Philippine coastal areas to show the relative worth of clean versus polluted beach front property.
- ♦ **Travel cost** determines the value people ascribe to recreational sites. It quantifies the total value of a site by calculating transportation costs, entrance fees, food, hotel as well as opportunity cost of travel time which considers lost time at work and foregone income. It assumes that the demand for recreation at the particular site is a function of environmental quality. The travel cost method is often used to support or cross-check other methods such as willingness-to-pay and could be used to value Philippine coral reefs among foreign scuba divers ^{34, 47, 59}.

C. Contingent valuation or methods using surveys to determine potential expenditures or willingness-to-pay

These methods determine willingness-to-pay or willingness-to-accept of individuals for certain environmental goods/services which are not priced. These techniques are also thus categorized under “constructed or hypothetical” markets, because questions posed regarding some environmental attributes presume that such a market exists.

- **Willingness-to-pay** refers to questions about certain attributes of the environment and its value to people. Collection of data is usually through a direct questionnaire and survey. This method estimates individual willingness-to-pay and then aggregates values for the target population. It is a useful tool and indicator of value and is used in the Philippines to determine what people will pay for entrance fees to parks, how much they might donate for conservation activities (existence value) and other environmental services^{11, 18, 34, 107, 128, 130}. The travel cost method can also be used to measure willingness-to-pay for certain use values such as recreation.
- **Compensation payments** estimate how much payment people are willing to accept as compensation for loss or declining quality of environmental goods or services. Willingness-to-accept values are always greater than willingness-to-pay values. This method has been used in the valuation of losses of marine product resources caused by coastal development in Tokyo Bay⁴⁴.

How do we compare benefits and costs to make decisions?

The various valuation methods listed above are normally applied in particular situations depending on the type of information available and the desired outcome of the valuation effort. Some valuation problems are matched with appropriate valuation techniques in Table 1.4.

One of the main reasons for valuing benefits of coastal resources is that once we are able to quantify the benefits derived from the resources, we can perform a benefit-cost analysis of the intervention being proposed to manage or protect the resource. Benefit-cost analysis compares the present value of all benefits (environmental, financial and social) with all costs associated with achieving a proposed outcome. It can give valuable insights into the economic efficiency of management and regulatory actions. The more benefits exceed the costs, the better off society is in economic terms as a result of the activity.

Table 1.4. Valuation techniques appropriate for certain benefits and costs of coral reef and mangrove protection⁹⁰.

Benefit/cost category	Suggested valuation technique(s)
I. On-site benefits	
A. Extraction	
1. Commercial fisheries	Market values of unprocessed fish
2. Local consumption	Value of labor input for collection or value of substitute good
B. Ecotourism	
1. Tourism revenues	Value of services, e.g. expenditures by tourists
2. Recreation	Willingness-to-pay through contingent valuation or travel cost method surveys
C. Scientific or education	Project costs or value of research outputs
D. Biodiversity improvement	
1. Gene resources	Patent values of genetic species
2. Species protection	Production value of species of concern
E. Ecological or ecosystem support	Market value of incremental catches
F. Non-consumptive benefits	
1. Existence	Willingness-to-pay estimates
2. Option value	Willingness-to-pay estimates
II. Off-site benefits	
A. Coastal protection	
1. Erosion control	Replacement cost, preventive expenditure
2. Local flood reduction	Replacement cost, preventive expenditure
3. Beach enhancement	Property value, replacement cost
B. Enhanced recruitment of fish	Market value of fish in other areas
III. Costs (on and off site)	
A. Management of area or resource	Project costs, opportunity cost approach
B. Losses from damage to system	Change in productivity (market value), loss of earnings, compensation payments

In this book, we evaluate the benefits of protecting coastal resources by establishing values for the various resources. The tradeoff of protecting and managing coastal resources with the alternative of not managing the resources and allowing them to be destroyed or degraded can also be evaluated using benefit-cost analysis. The methods summarized in this chapter can be used to perform most benefit-cost analyses and to determine the values of the resources of concern. Now let us explore the coastal resources and their values in greater detail in the succeeding chapters.

Chapter 2

Coral reefs: A highly productive but threatened ecosystem

“There have been people living near coral reefs since prehistoric times, making use of the rich source of food they provide as well as depending upon them for other common necessities such as tools (made from shells) and building materials for their houses.”

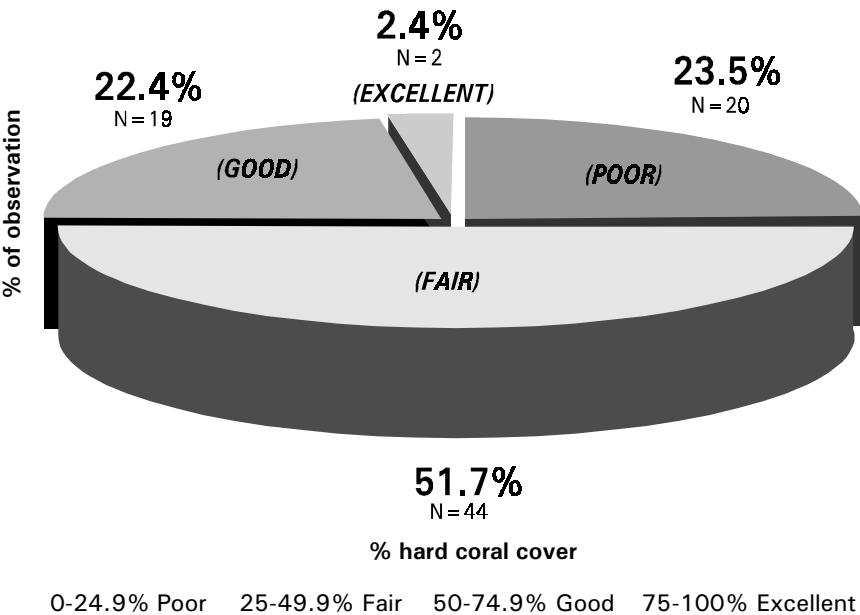
—The Greenpeace Book of Coral Reefs¹¹⁵

CORAL REEF EXTENT AND CONDITION

Coral reefs are the coastal ecosystem which provides the most substantial and sustainable source of sustenance to people in the Philippines^{3, 53, 117}. The 18,000 km coastline of the Philippines is estimated to have about 27,000 km² of coral reef fringing its shores or in offshore areas in the form of submerged reefs or coral atolls. This area is equal to slightly more than 10% of the total land area of the country⁵³. It is estimated that more than one million small-scale fishers depend directly on reef fisheries for livelihood²². In addition, reef fisheries supply a sizable amount of protein in a country where more than 50% of the animal protein is derived from marine fisheries and aquaculture.

The overall condition of the coral reefs in the country is not good. Most reef areas have been adversely affected by human activities and less than 5% are considered to be in excellent condition (Table 1.2; Figure 2.1). As coral reefs are destroyed, fisheries, tourism, coastal protection and biodiversity values are all lost⁹¹. The approximate economic losses being incurred from the destruction of coral reefs are presented in detail in this chapter. These losses, expressed in thousands of dollars per year per square kilometer of coral reef, have their greatest impact on local fishing communities and local tourism establishments. Such losses also reflect a general decrease in the recruitment of fish which could have emanated from damaged reef areas if they were still intact.

Figure 2.1. Status of Philippine coral reefs at 14 localities (About 75% of the reefs are in poor and fair categories)⁵³.



MANY USES OF REEF PRODUCTS AND THEIR VALUES

Fisheries and other reef resources used by people

Coral reefs in the Philippines can supply up to 35 t/km²/year (the highest reported fish yield from Sumilon Island in 1983) of edible and economically valuable fish and invertebrates assuming that ecologically sound fishing methods are used³. This unprecedented production is only one of the direct economic contributions coral reefs make to people. Other contributions include potential diving and snorkeling fees, and other existing tourism and recreation revenues, natural protection provided by reefs to shoreline structures from waves and storms, recruitment of fish and invertebrates to areas downstream from any given reef and unequalled biodiversity which humans want to preserve but have difficulty in assigning a measurable value to^{128, 129}.

Reef-related fisheries yield an estimated 9-12% of the world's total fishery of 70 million t/year^{77, 103} and are probably undervalued because of their subsistence use. The contribution of reef fish to the total fisheries of the Philippines ranges from 8 to 20% (or about 143,200-358,000 t)^{2, 24, 78}. The contribution of a reef fishery to some small island fisheries in the Philippines can go as much as 70% of the total fish harvest^{2, 3, 98, 99, 126, 127}. The average of documented reef yields for the Philippines is 15.6 t/km²/year as shown in Table 2.1.

Table 2.1. Yield of fishes from coral reef areas in the Philippines (updated from 93).

Location	Area of reef (km ²)	Depth used in estimate (m)	Yield (t/km ² /year)	Reference (numbers refer to those in reference list)
Sumilon Is	0.5	40	9.7 (76)*	(2)
Sumilon Is	0.5	40	14.0 (77)	(2)
Sumilon Is	0.5	40	15.0 (78)	(2)
Sumilon Is	0.5	40	23.7 (79)	(2)
Sumilon Is	0.5	40	19.9 (80)	(2)
Sumilon Is	0.5	40	36.9 (83)	(7)
Sumilon Is	0.5	40	19.9 (85)	(7)
Apo Is	1.5	60	11.4 (80)	(6)
Selinog Is	1.26	30	6.0 (82)	(5)
Hulao-hulao	0.5	15	5.2 (85)	(5)
Apo Is	0.7	20	31.8 (85)	(127)
Pamilacan Is	1.8	20	10.7 (85)	(98)
Apo Is	1.06	60	24.9 (87)	(17)
Bolinao Reef	42.0	RS	2.7 (90)	(72)
Bolinao Reef		RF	12.0 (90)	(72)
San Salvador	3.4	40	7.0 (89)	(28)
San Salvador	3.4	40	14.0 (90)	(28)
Mean for all sites (n = 17)			15.6	

*Year of data collection

RS - Reef slope

RF - Reef flat

Coastal people supplement their fish intake by the consumption of many invertebrates such as octopuses, bivalves (giant clams such as *Tridacna* sp. and other clams and oysters), gastropods, shrimps, spiny lobsters, sea urchins and sea cucumbers. In addition, hundreds of thousands of sea turtle eggs are harvested in the Sulu Sea Turtle Islands and other remaining sea turtle rookeries in the country.

Miscellaneous food products from the reef include edible algae, jellyfish and sea anemones. Consumption of these items depends on particular traditional and cultural preferences (Table 2.2).

Coral reefs have traditionally served as sources of building materials. Lime is extracted from Indonesian and Sri Lankan reefs for use in cement and plaster, and tiles have historically been made from massive corals in the Philippines. Sand extracted from reefs and adjacent beaches serves as a fill material and is widely used in cement mixes or to replenish beaches in other areas.

One type of interaction well developed on coral reefs is antibiosis, the production by one organism of substances that are harmful or repulsive to others⁵⁵. Some of these substances are used as essential pharmaceutical and industrial products. Ongoing research is discovering new uses for chemicals found in coral reef invertebrates which will add more pressure for exploitation. Sources range from sea hares to sea fans, anemones and nudibranch animals. Algae also provide a source of agar and carrageenan, the most common products of the seaweed growing industry.

In the late 1960s, international trade in ornamental corals, shells, sea turtles and coral reef fish began to flourish. These items now support large industries and end up mainly as decorative pieces in various parts of the world^{114, 115}. In the early 1980s, an average of 3,000 to 4,000 t/year of ornamental shells were exported from the Philippines mostly to the United States. This excluded the mother-of-pearl shell which is a large industry alone¹¹⁵. Live fish with a value of some US\$32 million were exported from the Philippines in 1996 for aquarium use—a decline from 1995 and previous years¹³. Before coral collection was banned in 1978, the Philippines was exporting an average of 1.8 million m³ of corals annually⁷¹. Even

Table 2.2. Coral reef resource products and uses (updated from 116).

Major reef export products of economic importance		
Resource	Role in reef	Product use
* Stony coral ^a	Primary reef frame builder	Building material, fish tank decoration
* Precious coral ^b	Enhances habitat	Jewelry, decoration
Fish ^b	Link in metabolism	Food, aquarium fish
* <i>Tridacna</i> clams ^b	Calcification	Shell collection, food
Top shells, <i>Trochus</i>	Calcification, food chain	Mother-of-pearl
Oysters ^b	Calcification, food chain	Pearls
Various gastropods ^b	Calcification, food chain	Collection, decoration, crafts
* Sea horses ^b	Food chain	Medicine, aquarium use
Lobsters ^b	Scavenger	Gourmet food
Sea cucumbers	Detritus feeder, sand	"Trepang," food
Sponges ^b	Borer	Toiletry
* Sea turtles ^b	Food chain	Shell, oil, meat, eggs
Sea snakes ^b	Food chain	Skin, crafts
Misc. invertebrates	Varied	Antibiotics, drugs
* Coral sand	Substrate, beaches	Concrete, building
* Ecosystem	Conservation, genetic diversity	Tourism, aesthetic appeal, natural laboratory
Subsistence food products commonly used		
Organism group	Kind	
Fish ^c	Most large and small ones	
Bivalves	Clams, mussels, oysters	
Gastropods	Most large and small ones	
Cephalopods	Squid, cuttlefish and octopus	
Crustaceans	Crab and shrimp	
Echinoderms	Sea cucumbers and sea urchins	
Coelenterates	Jellyfish and anemones	
* Sea turtles	All except hawksbills, eggs	
Algae	Many edible varieties	

^a1,830,089 m³ were exported from the port of Zamboanga in 1976⁷¹.

^bSeriously depleted on many reefs throughout the Philippines and Southeast Asia.

^cThe most significant contribution of reefs to subsistence food consumption in the Philippines and throughout Southeast Asia.

* Organism regulated by law in some form so that traditional use is no longer allowed or is controlled.

though bans exist on coral and sea turtle collection, these items continue to be harvested as noted by coral drying yards in some islands and reports of community residents. Sea snakes have been exploited primarily for skins and secondarily for meat since the 1930s in the Philippines⁸⁸ and are now too rare in numbers to support commercial collection.

A growing industry since about 1990 is the live food fish trade. About 840 t (net weight) were officially exported from the Philippines in 1996⁶⁰. This export depends primarily on Napoleon wrasses and a few species of grouper, rock lobster, stone fish and several others⁶⁵. One 40-kg Napoleon wrasse may sell for as much as US\$5,000 in Hong Kong⁶⁵. This industry adds value to reef fish by keeping them alive for sale in restaurants but has earned a bad reputation because of the rampant use of sodium cyanide in the capture of the fish. Since fishers are always under pressure to catch as many fish as possible with a minimum of effort, they use poison. Better economic incentives and law enforcement could perhaps change this scenario.

The international demand for these species is driving overexploitation, and as the price goes up with scarcity, the incentive to catch certain valuable species such as Napoleon wrasses is increased. Much of the exploitation of the various coral reef generated products has led to destruction and local extinction of the organism being collected and often its habitat. Usually the ecological and economic consequences of this blatant overexploitation using destructive techniques goes unnoticed and undocumented. Such practices of course will require both international and local economic and enforcement strategies to curtail.

Tourism uses of coral reefs

The aesthetic appeal, biological richness, clear waters and relative accessibility of coral reefs make them popular recreation areas for local and foreign tourists. In this sense, coral reefs are a valuable resource for the tourism industry. Skin and scuba diving, and underwater photography are common activities on reefs. Diving

tourism has increased substantially over the last ten years in the Philippines. Indeed, the tourism promotion strategy for the country by the Department of Tourism rests heavily on the natural attractions of coastal areas. A significant portion of visitors to the Philippines spend part or all of their stay in coastal areas with access to swimming, snorkeling or diving.

It is well accepted that the most popular diving resorts are in those locations where multiple dive sites with good and exceptional quality coral reefs can still be found. Examples include Mabini, Batangas, northern Palawan; the Central Visayas areas of Mactan Island, Cebu; Panglao, Bohol; and Negros Oriental as well as selected areas of Mindanao Island. Tourism is not likely to flourish where the reefs have been destroyed or damaged such as at Hundred Islands National Park in Lingayen Gulf where reef-viewing tourism has declined to almost nothing.

Shoreline protection role in the coastal environment

Fringing and barrier reefs are natural breakwaters which protect low-lying coastal areas from erosion, coastal flooding and other destructive action by the sea. Coral reefs also contribute to terrestrial accretion by providing sand for beaches and low islands through calcification processes^{54, 103}. These reef functions naturally protect thousands of coastal villages, low-lying coastal plains and coastal engineering structures, such as roads and bridges, built behind the outer edges of reefs along tropical coasts⁶⁷. If these reef buffers were removed, the equivalent artificial structures for protection would cost billions of dollars.

Biodiversity and other values from reef existence

The diversity of life on a coral reef per unit area is comparable to or greater than that in a tropical rain forest. This high diversity of life among a range of different types of plants and animals creates a rich and productive system which provides many of the useful products we have elaborated above. In addition, reef life

interactions have evolved a variety of unique chemical compounds (sometimes toxic) as their defense strategy. Many of these compounds have no terrestrial counterparts⁵⁷. In this regard, the potential for discovery of useful chemicals for medicine and other uses is very high. The existence of this potential highlights the need to maintain healthy and evolving reef systems so that potential future uses are not sacrificed in the present.

Coral reefs are known as good laboratories for ecological science. They provide excellent in-situ classrooms for students at the high school and college levels. Many ecological relationships are easily seen and explained on coral reefs because so much life can be observed at close range. Since many school children in the Philippines have little contact with their natural environment, coral reefs provide an excellent opportunity to expose large numbers of students to one of the most interesting and complex ecosystems in the world. Locales like Olango Island, Cebu, and Batangas, which are accessible from urban areas, can play important roles in educating the youth about marine ecology and conservation.

Aesthetic appeal is a final important resource of coral reefs. Although not easily quantified as other resources associated with the reef system, it is really this aspect which attracts most tourists to view reefs. Most reef visitors as well as some people who never even travel to see a reef will contribute to protection efforts just to know that the aesthetic value of a coral reef is maintained into perpetuity.

WHAT IS LOST AS REEFS ARE DESTROYED?

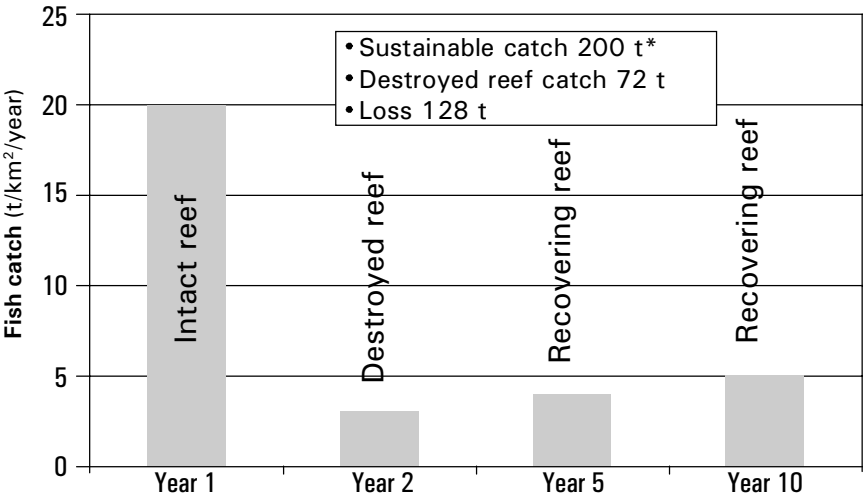
Human activities and their impacts on coral reefs are summarized in Table 2.3. It is noted that there are many destructive activities to reefs and that some, like overharvesting, are not obviously damaging unless we understand the various cause and effect relationships⁹⁵. The purpose of this book is not to analyze the causes of destruction. Rather, the focus is to highlight economic losses from destruction of reefs so that we will have a better sense of what is at stake.

Table 2.3. Human activities and their adverse impacts on coral reefs¹¹⁷.

Activities	Impacts
Extraction of coral limestone	Reef foundation degradation, habitat destruction
Extraction of coral sand	Turbidity, water flow dynamics, erosion
Explosive fishing techniques	Habitat destruction, loss of productivity and biodiversity
Terrestrial sediments from human activity	Turbidity, smothering
Physically damaging fishing method	Habitat destruction
Reef trampling by humans and anchors	Habitat destruction
Overexploitation of fish and invertebrates	Changes in ecosystem balance, decrease in sustainable yield
Aquarium fish collection	Selective depletion of population
Urban-industrial pollution	Biological degradation
Oil spill	Biological degradation
Oil drilling	Turbidity, habitat destruction
Fish poisoning	Biological degradation, habitat destruction
Spear-fishing	Selective depopulation of fish
Construction	Habitat destruction, turbidity
Tourism	Collecting, minor habitat disturbance
Thermal or salinity changes	Detrimental to coral polyps and invertebrates

Before we look at the economic consequences of coral reef loss, it is useful to consider fish catch alone. Loss in sustainable fish yield from 1 km² of healthy coral reef over ten years which has been partially destroyed by blast fishing or use of poison, for example, is approximately 128 t of fish for a moderately productive coral reef area under relatively undisturbed conditions (Figure 2.2). After partial destruction, coral reefs do not quickly return to a high level of productivity. It may take up to 50 years for a dynamited reef to regain 50% of its original healthy state and to be productive again⁴. Let us now look at the various reef uses and their values.

Figure 2.2. Fish yield decline and loss on a destroyed and recovering coral reef over 10 years.



* Assumes a good quality coral reef with a yield of 20 t/km²/year and use of non-destructive fishing methods

One way to analyze the loss from reef destruction is to compare the net benefits to individuals involved in destructive activities as compared to the net losses to society from the decreased production of the coral reef ecosystem. This type of analysis is summarized in Table 2.4 and shows the losses to fisheries, coastal protection and tourism²⁵. For example, the total net present value of quantifiable loss from overfishing 1 km² of coral reef over a 25-year period and discounted at 10% is US\$108,900. Although overfishing does not destroy a coral reef, it lowers its natural productivity and the potential of the reef to attract tourists who want to see a diversity of large fish. On average, coral reef fisheries could produce an additional US\$70,000 in net present value per km² of reef if effective management was introduced²⁵. In Bolinao, Philippines, an extensive research effort determined that fishing effort must be reduced by 60% to avoid overfishing and achieve optimal sustainable yields⁷².

The losses to society from blast fishing, known to shatter the physical structure of the coral reef, are shown in Figure 2.3. Here,

the net benefits from blast fishing in the form of fish harvested are only about US\$15,000 (net present value over 25 years for 1 km² of reef). In contrast, the net present value of losses to society in terms of foregone coastal protection (US\$193,000), earnings from sustainable fisheries (US\$86,300) and tourism (US\$482,000) is many times higher than the gain to the blast fisher(s).

Table 2.4. Total net benefits and losses due to threats of coral reefs²⁵.
(present value; 10% discount rate; 25 years; in thousand US\$; per km²)

Function Threat	Net benefits to individuals	Net losses to society					
		Fishery	Coastal protection	Tourism	Food security	Bio- diversity	Total net losses (quantifiable)
Poison fishery	33.3	40.2	0.0	2.6-435.6	n.q.	n.q.	42.8-475.6
Blast fishing	14.6	86.3	8.9-193.0	2.9-481.9	n.q.	n.q.	98.1-761.2
Coral mining	121	93.6	12-260.0	2.9-481.9	n.q.	n.q.	175.5-902.5
Sediment-logging	98	81	-	192.0	n.q.	n.q.	273.0
Overfishing	38.5	108.9	-	n.q.	n.q.	n.q.	108.9

n.q. - not quantifiable

Another powerful example shows the impact of pollution from the large city of Jakarta on the average depth of coral reefs in Jakarta Bay (Figure 2.4). Because of increasingly turbid water and the presence of various pollutants the average depth of corals has decreased from about 10 m in 1931 to a present average depth of less than 1 m¹⁰⁸. In many areas, the reefs are dead so that all economic and ecological benefits have been eliminated. This scenario, although not well-documented, appears to be occurring near the cities of Cebu, Manila and others and will have a similar impact on Philippine reefs if unchecked.

In addition to reef growth, reef fisheries lose much of their productivity in areas where siltation is prevalent. The coral reef fishery of the Lingayen Gulf was analyzed for losses from siltation where damages are computed as the difference between potential

Figure 2.3. Net present value of blast fishing to individuals and associated losses to society per km² of reef from destruction to tourism, physical coastal protection and foregone sustainable fishery income (in thousand US\$; over 25 years; 10% discount rate)²⁵.

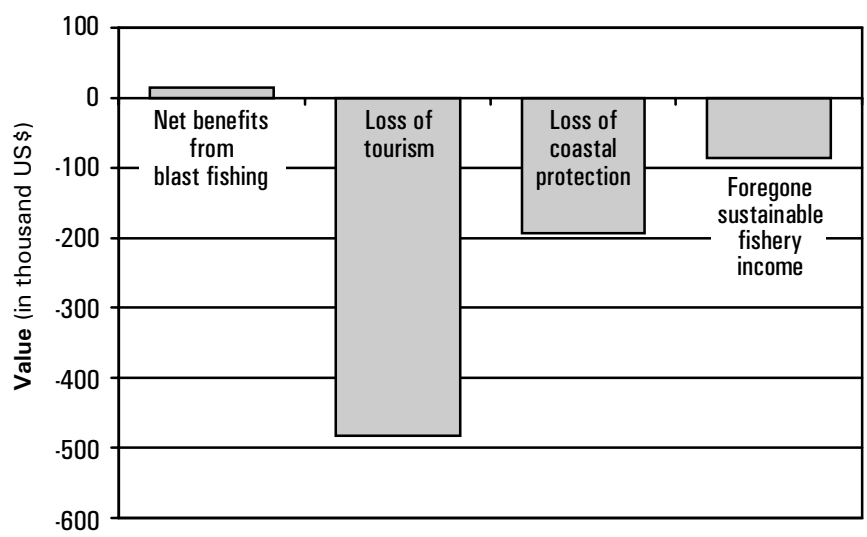
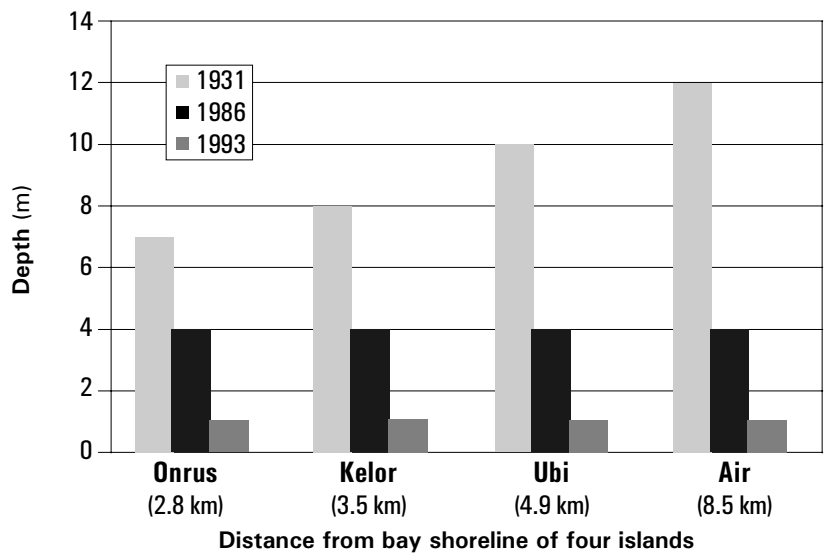


Figure 2.4. Changes in average depth of coral growth caused by increasing water pollution in relation to distance from shore and time in Jakarta Bay¹⁰⁸.



yields of good and degraded coral reefs. Using the stated difference in productivity of a good and degraded reef, Padilla et al.⁸³ estimated damage to municipal fisheries of the area amounted to P6.17 million (US\$250,000) in 1995.

The economic value of shoreline protection from the presence of coral reefs has been estimated for different situations around the world. In Sri Lanka, the commonly quoted cost to illustrate the economic value of beach and shore protection from wave action and currents due to the presence of coral reefs is the cost of building shoreline revetments and structures to prevent erosion. The one-time cost of building such structures not including maintenance is about US\$1,000/m of shoreline or about US\$1 million/km⁸⁰. And to make matters worse, these structures are not permanent and require expensive maintenance³².

Another estimate uses the value of coastal roads and other structures along the shoreline in rural Indonesia which are physically protected by the presence of a reef. The cost per km of roads ranges from US\$5,000 to 50,000 depending on quality and terrain. With this information, US\$25,000/km has been used to estimate the value of shoreline protection provided by the existence of coral reefs in Indonesia²⁵. This value is used in this book unless coastal circumstances dictate otherwise.

ECONOMIC GAINS FROM CORAL REEF PROTECTION

The returns from coral reef protection and management are really just the other side of the destruction and loss equation. First, it is useful to summarize the productive fishery aspects of reefs and the potential gains from well-managed tourism. All the potential benefits from 1 km² of good quality and healthy coral reef are shown in Table 2.5. These values assume a typical coral reef in the Philippines with no overfishing or destruction and some moderate level of tourism potential.

The sustainable fisheries (local consumption) potential for our example coral reef in Table 2.5 is based on known fish yields

Table 2.5. Sustainable annual coral reef economic benefits (direct and indirect) per 1 km² of typical healthy coral reef in the Philippines with tourism potential.

Resource use	Production range	Potential annual revenue (US\$)(range)
Sustainable fisheries ^a (local consumption)	10 to 30 t	15,000-45,000
Sustainable fisheries ^b (live fish export)	0.5 to 1 t	5,000-10,000
Tourism ^c (on-site residence)	100 to 1,000 persons	2,000-20,000
Tourism ^d (off-site residence)	500 to 1,000 persons	2,500-5,000
Coastal protection ^e (prevention of erosion)		5,000-25,000
Aesthetic/Biodiversity value ^f (willingness-to-pay)	600 to 2,000 persons	2,400-8,000
Total		31,900-113,000

Assumptions:

^aAverage market price of US\$1.5/kg of reef fish^{20, 127}.

^bAverage market price to fishers of US\$10/kg of live reef fish¹³.

^cAverage expenditure of US\$20/day/tourist staying at the site¹¹³.

^dAverage expenditure of US\$5/day/tourist for purchases at the site¹¹³ (A. White, pers. obs).

^ePhysical protection value of US\$5,000-25,000/km/year of reef front beach²⁵.

^fAverage expenditure of US\$4/day for entrance to marine sanctuary or for a donation to the maintenance of the area or anchor buoys¹¹.

from coral reefs noted above (Table 2.1). Sustainable fisheries (live fish export) is based on the presumption that a small portion of all reef fish capture could be harvested for live fish export which brings a higher value than local consumption of dead fish. This conservative estimate is used to illustrate the higher return from fish export and the potential value added for a small portion of reef fish yield.

Tourism (on-site residence) is based on documentation of tourism at Apo Island, Negros Oriental, where up to 1,000 tourists come annually to the island as residents for at least one night. A conservative estimate of their expenditure (US\$20/person/night) represents direct revenue to island residents as a result of the presence of their coral reef. Tourism (off-site residence) represents the visitors

who come to Apo Island for day visits and spend a small amount on the island for food or souvenirs (US\$5/person/day). These same tourists also contribute a much larger sum to economies outside of the island but cannot be directly attributed to the presence of the coral reef of the island visited.

Finally, the aesthetic and biodiversity value of the reef is based on a contingent valuation survey for Philippine reefs in the tourism areas of Mabini, Batangas; Mactan Island, Cebu; and Panglao Island, Bohol¹¹. The willingness-to-pay of visitors for entrance to marine reserves and sanctuaries and for the placement of anchor buoys is summarized in Table 2.6. This substantial amount of revenue is being foregone for the management and conservation of coral reefs which could be collected from some visitors if they knew that the fees collected were for specific uses. Based on the average number of visitors, the gross annual revenue from entrance fees and donations to anchor buoys being foregone from Mabini, Batangas, alone is estimated at more than US\$300,000 (Table 2.7). This small sample survey is only indicative for the Mabini area and may not be representative for other parts of the country.

If we carry the analysis one large step further using conservative estimates of annual revenues from 1 km² of coral reef in the Philippines, we realize that the reefs in the country contribute an enormous amount to the economy of local communities and the nation. With 27,000 km² of coral reef, if 50% of this is in a condition which will support the estimated revenues of Table 2.5 at an average level, coral reefs contribute almost US\$1 billion annually to the Philippine economy. In this light, the habitat losses from destructive fishing are huge and not justified^{69, 70}.

Several well-documented coral reef areas in the country will help to illustrate the sizable benefits derived from coral reef management. One example, Tubbataha Reef National Marine Park and World Heritage Site, is a large coral reef atoll in the middle of the Sulu Sea. This reef contains one of the most diverse and potentially productive coral reefs in the country and in Southeast Asia¹². Although the cost of management and protection has not been estimated, the potential annual economic benefits from the

Table 2.6. Willingness-to-pay (WTP) to enter a marine sanctuary and to maintain anchor buoys in three popular scuba diving areas, Philippines¹¹.

	Mabini, Batangas	Mactan Island, Cebu	Panglao, Bohol
Entrance to marine sanctuary	n = 37	n = 39	n = 44
Average WTP (daily/person)	P92 \$3.54	P139 \$5.34	P85 \$3.27
Donation to anchor buoy maintenance	n = 37 P235*	n = 36 P138**	n = 46 P78**
Average WTP	\$9.04	\$5.31	\$3.00

* Annual donation per person.

** Daily donation per person.

US\$1 = 26 pesos in mid-1997

Table 2.7. Total potential annual revenues from entrance fees to marine sanctuaries and donations for anchor buoy maintenance in two popular scuba diving areas, Philippines¹¹.

	Mabini, Batangas ^a (n = 37)	Panglao, Bohol ^b (n = 44)
Entrance fees	P5,936,740 - P7,272,966 (\$228,336-\$279,729)	P460,080 - P690,120 (\$17,695 - \$26,543)
Donation for buoys	P504,957 - P618,611 (\$19,421-23,792)	P419,580 - P629,370 (\$17,695 - \$24,205)

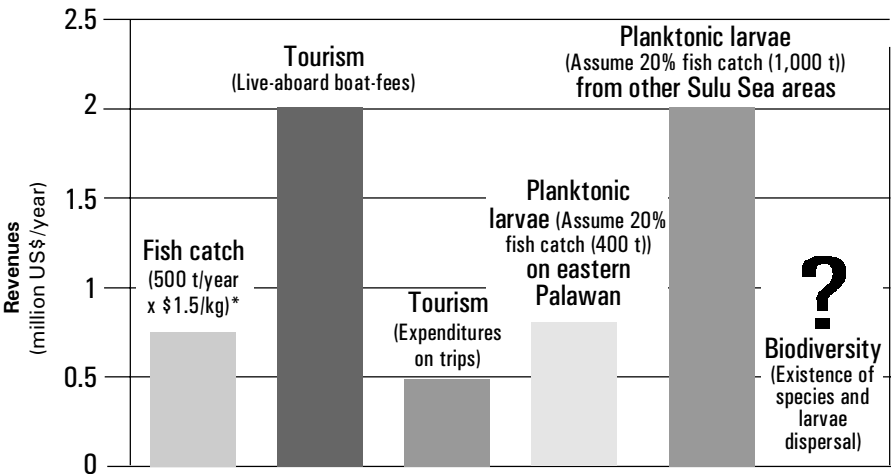
^aStudy estimated a minimum of 64,600 and a maximum of 79,140 visitor days per year.

^bStudy estimated a minimum of 5,400 and a maximum of 8,100 person diving days.

US\$1 = 26 pesos in mid-1997

continued healthy existence of the reef area are substantial (Figure 2.5). With benefits totaling more than several US\$million/year, it is easy to justify the cost of management, which is much less as shown for Apo Island below.

Figure 2.5. Annual direct and potential indirect economic revenues derived from Tubbataha Reefs (conservative estimates)^{12, 123}.



*This estimate is based on potential fish yield if fishing were allowed in the park. It is noted that the direct fish catch is valued much lower than other economic revenues from the park.

Now, if we look at the cost of management of 1 km² of coral reef, we can decide if the investment is justified based on the known benefits. First, if left alone without any disturbance except non-destructive and managed fishing and tourism practices, a coral reef will do very well and produce the revenues indicated above. But assuming we need to control damage and bring back the natural status quo, we have to support management programs. Apo Island provides an example to compare the costs of management with the revenues gained over the last 15 years.

Conservatively, Apo Island coral reef covering slightly more than 1 km² to the 60-m isobath, can support an annual revenue from sustainable fishing and tourism of about US\$50,000/year^{113, 127}

Figure 2.6. Annual gross revenues derived from the existence of one small marine sanctuary on Apo Island, Negros which was established in 1985 and receiving between 500 and 1,000 tourists annually^{113, 127}.

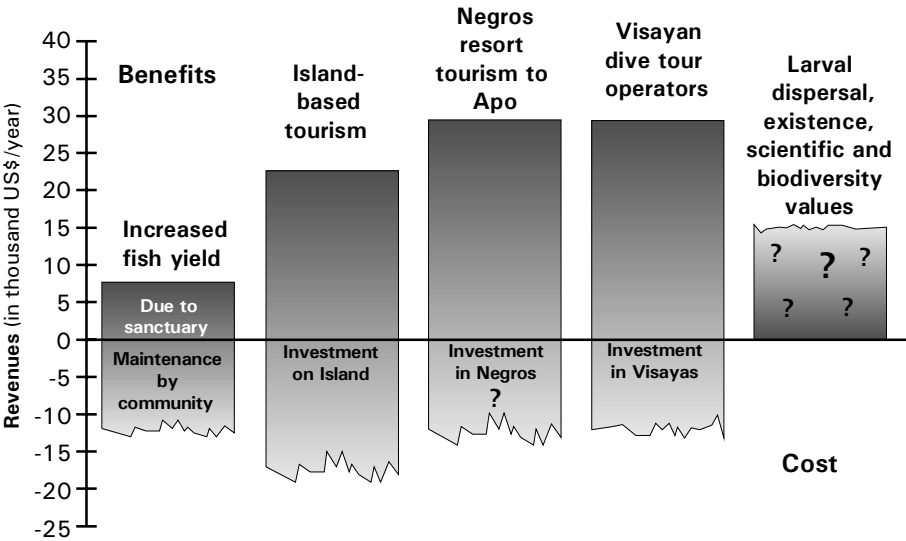
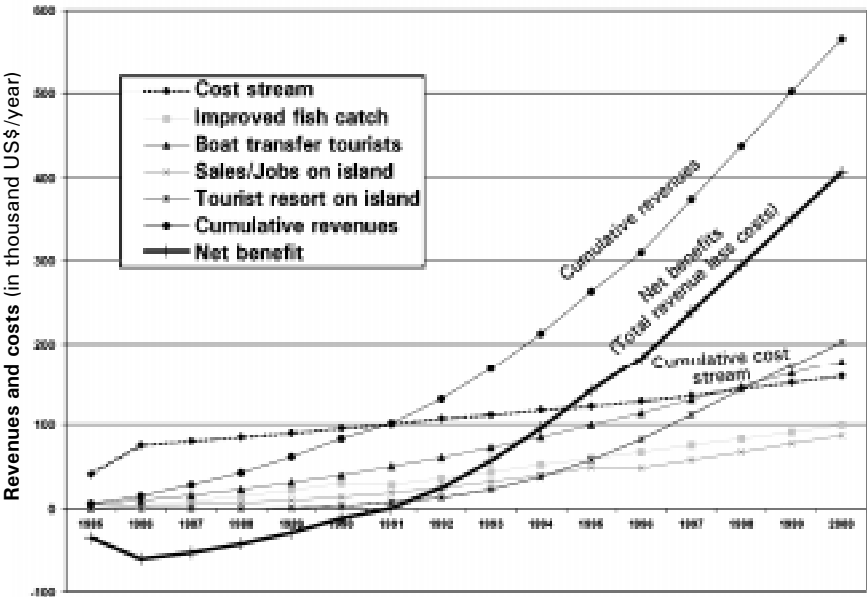


Figure 2.7. Accrued revenues and costs from the sustainable use of Apo Island coral reef and fishery resources^{113, 122, 127}.



(Figure 2.6). What is the cost of management to guarantee this annual revenue? In 1985 and 1986, a conservation project for Apo Island helped establish the current regime of a marine reserve and sanctuary managed by the island community. The project for Apo Island cost about US\$75,000. The annual maintenance cost since then has been about US\$5,000 to a variety of interested parties such as volunteers of the barangay and municipal government, Silliman University, the Department of Environment and Natural Resources and contributions from visitors to the island. Based on this, it appears that the cost of management is easily justified given the annual revenues now accruing to the island residents and tourism operators (Figure 2.7). It should also be noted that the cost of management is generally not borne by the persons who gain most from the reef-generated revenues! In this case, the costs were initially borne by Silliman University, a foreign donor and outside volunteers.

Chapter 3

Mangroves: The fastest growing forest ecosystem

“Oh these mangroves. I never saw one that looked as if it possessed a decent conscience. Growing always in shallow stagnant waters, filthy black mud, or rank grass, gnarled, twisted, stunted and half bare of foliage, they seem like crowds of withered, trodden-down old criminals, condemned to the punishment of everlasting life. I can’t help it if this seems fanciful. Anyone who has seen a mangrove swamp will know what I mean.”

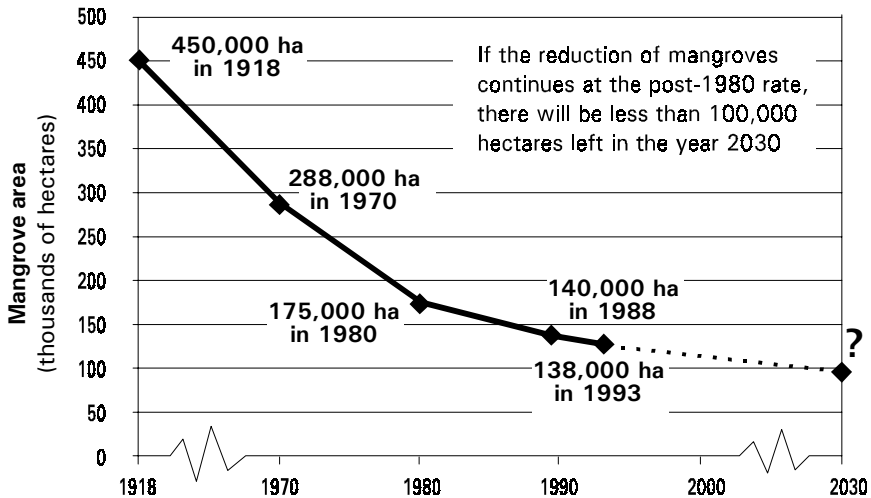
- An early New Zealand novelist¹¹²

MANGROVE FOREST (EXTENT AND CONDITION)

Mangroves are highly productive forests growing along tropical tidal mudflats and along shallow water coastal areas extending inland along rivers, streams and their tributaries where the water is generally brackish. As an ecosystem, mangroves form a unique association of plants dominated by the mangrove forest as the primary producers interacting with associated fauna and the physical environment. Mangrove plants are unique for being able to get established and survive in a waterlogged and saline soil. Mangrove ecosystems have extremely high natural productivity in terms of plant growth and all the associated organisms. Much of this productivity translates into useful products for people in the form of wood, fish and crustaceans and various other ecological and economic benefits^{75, 97}.

Some 450,000 ha of mangroves existed in the Philippines in 1918 (Figure 3.1). In 1970, the country’s mangrove forest area was pegged at 288,000 ha. By 1988, the mangrove cover sank to 140,000 ha. From 1988 to 1993, the mangrove cover declined to only 138,000 ha. Thus, from 1918 to 1970, an average of 3,100 ha of mangroves were lost every year, increasing to about 8,200 ha annually from 1970 to 1988^{40, 124}.

Figure 3.1. Mangrove resource decline in the Philippines^{40, 132}.



This loss is mostly attributed to the conversion to fishponds during the 1960s and 1970s. Other factors which have contributed are reclamation for residential and industrial purposes, overharvesting of mangrove trees for charcoal or fuelwood production, lack of reforestation and physical expansion of coastal communities⁷⁴.

At present, 95% of the remaining mangroves are secondary growth and only 5% are old or primary mangroves which are mostly found in Palawan⁷⁴. Most mangrove areas in Luzon and Visayas islands are made up of reproduction brush and young growth. Thus, mangrove forests remaining along Philippine coasts today are of much lower quality than early in the century and they cover less than one-third of their original area. This has occurred because of the lack of consciousness on the substantial economic and ecological contribution of this ecosystem to society.

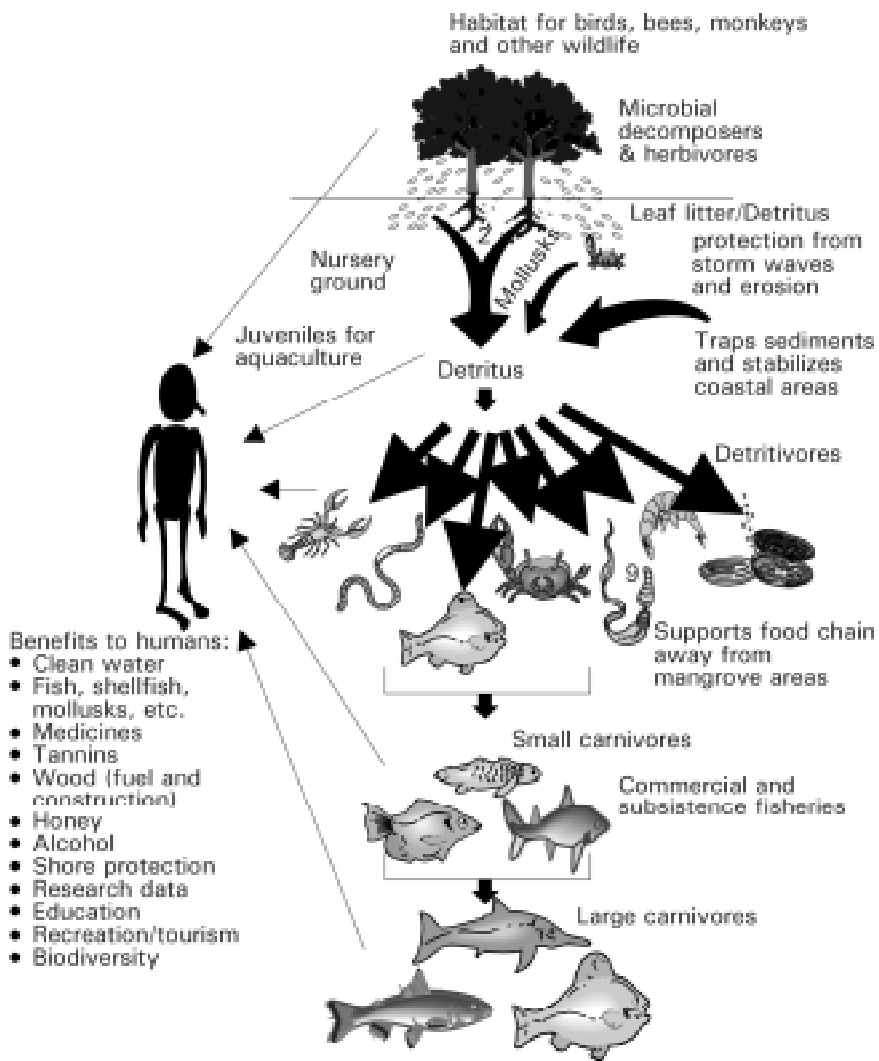
MANY USES OF MANGROVE PRODUCTS AND THEIR VALUES

The depletion of mangroves can be traced to the various types of direct and indirect economic goods that are derived from the ecosystem which ignores the longer-term benefits from their continued existence. The primary ecological and economic benefits and functions of the mangrove ecosystem are (Figure 3.2):

- Provision of nursery grounds for fish, prawns and crabs and support of fisheries production in coastal waters;
- Production of leaf litter and detrital matter which are broken down by bacteria, fungi and other micro-organisms, which in turn provide a valuable source of food for marine animals in estuaries and coastal waters;
- Protection of shore of the lagoons and the estuaries from storm waves and erosion;
- Reduction of some organic pollution in nearshore waters by trapping or absorption;
- Recreational grounds for bird watching and observation of other wildlife; and
- Access to a high diversity of mangrove plants and animals, and their adaptations, making them ideal field laboratories for biology and ecology students and researchers.

In addition, various types of end consumers depend on mangroves. People collect firewood, charcoal and use posts for their fishing traps and housing materials; and from the mudflats are harvested various species of fish, crustaceans and mollusks. Aquaculture and commercial fisheries depend on mangroves for on-site and off-site goods such as juveniles and mature fish species. Meanwhile, the biochemical industry utilizes mangroves for tannin, alcohol and medicinal resources.

Figure 3.2. Mangroves and their ecological and economic benefits⁷⁹.



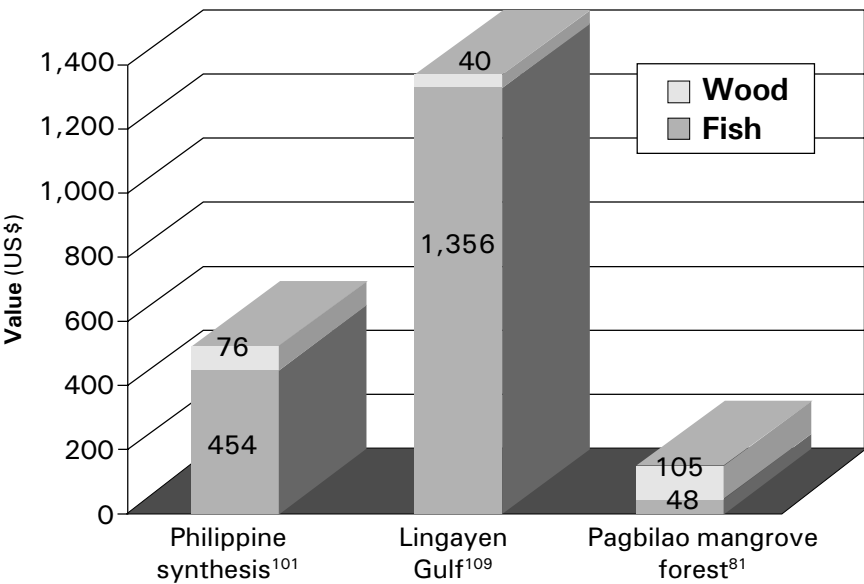
WHAT IS LOST WHEN MANGROVES ARE DESTROYED?

In 1977, researchers compiled data on the correlation between the incidence of mangrove forests and wild commercial shrimp production in Indonesia. The evidence showed that the largest shrimp catches were in areas offshore from sizable mangrove

forest stands⁶⁸. Subsequently, the annual shrimp catch near the coast of southern Java, Indonesia, associated with a 22,000 ha mangrove forest and estuary was valued at US\$12 million in 1988 (US\$545/ha).

Direct economic values estimated in the Philippines for mangrove wood and fish products combined range from US\$153 to 1,396/ha/year (Figure 3.3)^{1, 23, 48, 81, 101, 109}. The lower estimate⁸¹ is based on the Pagbilao mangrove forest for which direct observation of occurring species (for both fish and forest) was made in a relatively degraded mangrove area. The estimates of Schatz¹⁰¹ and Trinidad¹⁰⁹ are indicative figures on a national scale and are updated by using inflation assumptions of 2.5% per year. The estimates do not include revenues generated from aquaculture in the area. Also, a sustainable forestry regime is assumed despite the national prohibition on mangrove cutting; thus, revenues from wood products are generated.

Figure 3.3. Summary of Philippine estimates for mangrove values^{81, 101, 109}.



Note: The larger figures for Lingayen Gulf reflect a different methodology than those for the others which are more conservative estimates.

The range of values is consistent with a study that estimates the value of a complete mangrove ecosystem to be in the range of US\$500-1,550/year⁴². This can be considered to be the minimum valuation of loss when mangroves are converted to other land use forms. Mangroves in Trinidad, Fiji and Puerto Rico were valued at US\$500, US\$950-1,250 and US\$1,550/ha/year, respectively⁵⁵. The value of mangroves in Chanthaburi, Thailand, at US\$590/ha/year falls within the range²⁷. The mangroves of Bintuni Bay, Indonesia, have been valued for forest and fishery resources at US\$1,333/ha/year while that of traditional uses amounted to US\$650⁹².

It is difficult to maintain a consistent level of economic value from mangroves because of the disparity of study sites, the differences in development conditions, the research techniques used, and the overall scope or focus of studies. Values are often site-specific simply because of variation in the mangrove ecosystem among other factors.

A compilation of information from around the world on the annual value per hectare of mangrove and tidal marsh areas confirms our estimates for the Philippines. These values shown in Table 3.1 also include estimates for “disturbance regulation” and “waste treatment” which have not yet been estimated for Philippine mangrove forests.

Table 3.1. Summary of mangrove ecosystem value averages from around the world³⁵.

Benefits of ecosystem services	Value (US\$/ha/year)
Disturbance regulation	1,839*
Waste treatment	6,696*
Habitat/refugia	169
Food production	466**
Raw materials	162**
Recreation	658*
Total benefits	3,294

*Disturbance regulation, waste treatment and recreation are generally not economically quantified in the Philippine context because they are indirect services which are difficult to quantify. In other countries, these services are valued more highly and will thus affect management decisions regarding mangroves.

**It is reassuring to note that the combined values for “food production” and “raw materials” (US\$628) is very close to the accepted values for Philippine mangroves for fish and wood products and what is being used in this book.

Despite some variation of values, there is definitely a monetary basis for protecting mangroves, even if only to maintain their present economic benefits. Based on the above estimates, US\$600/ha/year (US\$60,000/km²/year) is used in this book as the acceptable economic equivalent to indicate what is lost if mangroves are converted to other uses.

ECONOMIC JUSTIFICATION FOR MANGROVE MANAGEMENT

In deciding how to maximize economic gain from mangroves, discussions usually focus on the “economic rent” which should be charged to lessors for alternative uses of the habitat area. In one research effort to determine an optimal system for leasing out mangrove areas for fishpond use, three management scenarios were compared: (i) mangrove plantation, (ii) managed naturally regenerated mangroves, and (iii) unmanaged understocked stands¹⁰¹. The value of wood products from mangrove plantation generates more revenues than alternatives (ii) and (iii) but for practical purposes, scenario (ii) was recommended as a basis for economic rent for mangrove habitats converted to fishpond (Table 3.2). The higher value in all three options is not the wood products but the fish products (US\$538/ha) dependent on the existence of the ecosystem. This amount can be considered as a minimum economic gain from a healthy mangrove ecosystem.

Table 3.2. Estimated net annual economic value (in US\$/ha) of Philippine mangrove areas for different levels of management¹⁰².

Level of management	Wood products (value/ha)	Fish products (value/ha)	Total (value/ha)
Mangrove plantation	156	538	694
Managed naturally regenerated	90	538	628
Unmanaged understocked stands	42	538	580

Note: Wood harvest value based on average price of about US\$12/m³ of wood; fish products based on average annual weight of fish and shrimp/ha associated with mangrove areas and an average price of US\$0.80/kg; values based on Philippine pesos. US\$1 = 25 pesos in 1991.

Mangroves in Lingayen Gulf have been severely overharvested for wood products; meanwhile, the degraded mangroves have been converted into milkfish ponds. Pond culture continues to be a thriving industry in the area and thus, there is impetus for further conversion of lands. This situation prompted a study using the total economic value (TEV) approach to evaluate land conversion³⁶. There are existing patches of mangroves in Lingayen Gulf and for theoretical purposes, the conversion of such was also considered. The study estimated the TEV of mangroves by looking at direct economic benefits (fish and wood), indirect economic benefits (value of agricultural production), foregone benefits (income foregone from agriculture due to salinization of aquifers) and irreversible damage to the ecosystem brought about by conversion. Generally, the results show that maintaining mangroves in their present form, instead of converting them into aquaculture farms, is the superior alternative using a future value and foregone earnings approach. The only exception to this is in a few areas where mangroves are already severely degraded so that the development options may provide more long-term benefits compared to the cost of rehabilitation.

While the studies utilize different approaches for mangrove valuation, a unanimous conclusion is that management and protection result in more and longer-term benefits. Strategies that espouse partial conversion of mangroves are also economically tenable but the bottom line is that the natural productive benefits from mangroves endure over time. Healthy mangrove ecosystems continue to supply fish products, wood and other useful products to people regardless of other factors as long as basic environmental parameters are honored. In contrast, intensive aquaculture is plagued with disease, acid soil, market fluctuations and water quality problems, all of which undermine economic viability. This is why many shrimp farms have closed in the Philippines and elsewhere in Southeast Asia, leaving many abandoned and degraded mangrove habitat areas.

Mangroves also provide benefits which have not yet been measured in monetary terms within the Philippine context. These include disturbance regulation which includes natural processes such

as stabilizing land from erosion, preventing floods and absorbing organic waste. In addition, mangroves provide habitats for animals (estuarine fish and terrestrial mammals) which may be valuable to people and biodiversity in general. Finally, the recreation and tourism value of mangroves is only beginning to be explored. In Bais Bay, Negros, for example, a mangrove park has been established which attracts many visitors. A similar mangrove sanctuary is functioning through community efforts in Kalibo, Aklan, which makes money for the community, educates and entertains visitors. These values have been estimated in other parts of the world and are shown in Table 3.1.

The total gain to the Philippines for protecting its remaining mangrove ecosystem is substantial. Using the conservative estimate of value from direct benefits of only US\$600/ha/year, the Philippines gains at least US\$83 million/year in fish production and potential sustainable wood harvest from the existing 138,000 ha. If we could increase the area of healthy mangrove forest to 200,000 ha, the annual natural benefits would potentially increase to US\$120 million for a gain of about US\$37 million/year.

Chapter 4

Fisheries: The single largest source of protein in the Philippines

[In the past] *“Teach a man to fish and he will have food for the rest of his life.”*

[Now] *“Teach a man to fish and he will resort to unsustainable methods to remain competitive with the overabundance of fishermen.”*

—Anonymous

IMPORTANCE AND TRENDS OF FISHERIES

The Philippine population is highly dependent on fish food. Recorded per capita consumption of the *“fish, meat and poultry food group”* is 54 kg/year in 1993 of which 67% is comprised of fish and fish products²¹. The food group that includes fish is thus the second most important component of the Filipino diet next to rice.

On a national scale, fisheries contributed 3.5% to the gross domestic product (GDP) and 16% of gross value added (GVA) in the agricultural, fishery and forestry sectors in 1996, both at current prices. In the same year, exports of fishery products amounted to P15 billion (US\$600 million) with the top commodity exports being tuna, shrimp and seaweed, in descending order of importance²².

The fishing industry also provides employment to about one million people, roughly 5% of the country's labor force. Of this, 68% is accounted for by the municipal fishing sector, 28% is accounted for by aquaculture, and the rest by the commercial boats²². Because commercial boats account for 30% of the catch and employ only 6% of the fishing labor force, there are strong sentiments being aired about limiting commercial fishing boats to areas outside of municipal waters.

Fisheries production in 1996 totaled 2.8 million t (Table 4.1). This production is divided almost equally between the

municipal, commercial and aquaculture sectors. Aquaculture production has almost doubled in the last ten years although most of the increase is from farming of non-edible seaweeds. The municipal sector shows a steady downtrend. Its contribution to total production decreased from 57% in the early 1970s to just 30% in 1996. In general, production growth has been very minimal over the last five years, averaging 1.5% per year while catch per unit effort has steadily declined (Figures 4.1 and 4.2).

Table 4.1. Philippine fish production by sector, 1996²².

Sector	Quantity (in 1,000 t)	%	Value (in billions of pesos)	%
1. Aquaculture*	981	35.4	33.2	40.0
2. Municipal fisheries	909	32.9	25.4	30.5
3. Commercial fisheries	879	31.7	24.5	29.5
Total	2,769	100.0	83.1	100.0

*About 60% of aquaculture production is actually seaweeds farmed for industrial processing and export.

Figure 4.1. Trend of catch per unit effort since 1948³⁹.

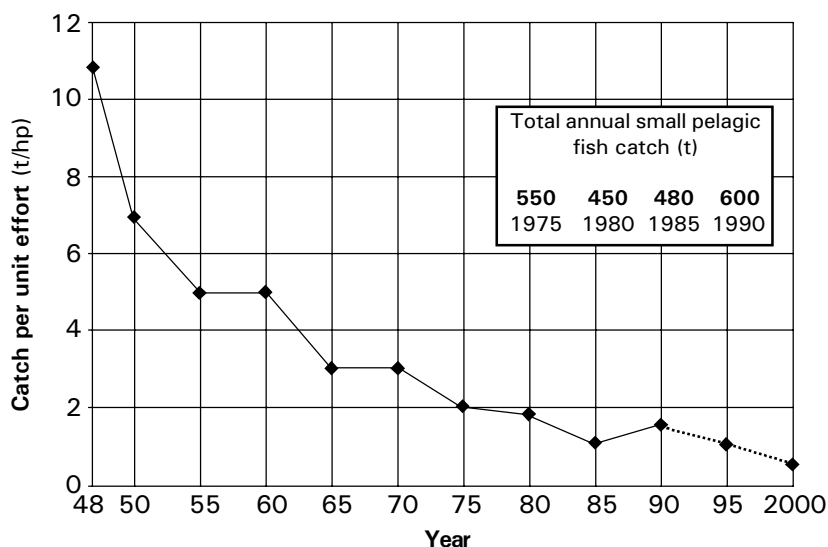
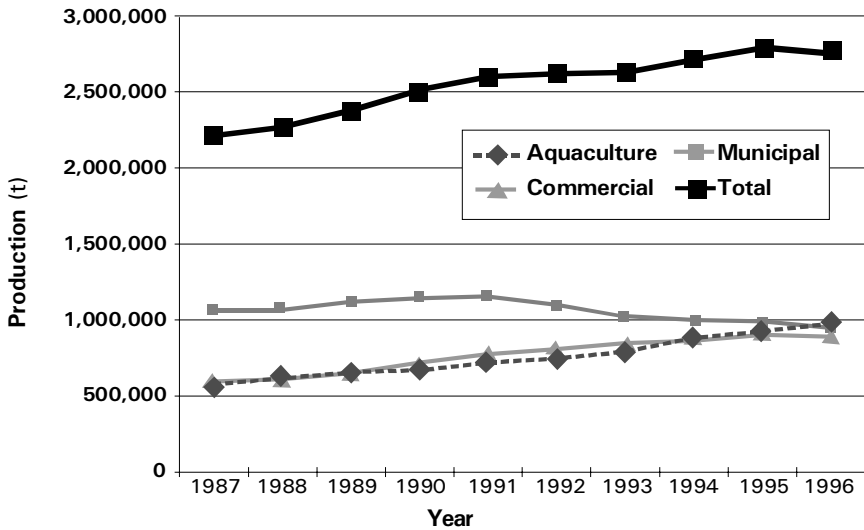


Figure 4.2. Trends in Philippine fish production, 1987-1996²².



There are clear signs that Philippine open-water fisheries have reached their sustainable limits and, as noted, municipal fisheries are declining. One primary reason for the decline of these nearshore and small-scale fisheries is that they are habitat dependent. And, as shown in Chapters 2 and 3, the viable and healthy coral reef and mangrove ecosystem area has decreased significantly over this century. The result is a decrease in fish catch and a drastic decrease in catch per unit effort as shown in Figure 4.1.

KEY FISHERIES, THEIR CONDITION AND VALUES

Nearshore fisheries

Nearshore fisheries can correspond to either of two characteristics: spatial and technological. Spatially, the nearshore fishery covers the 0-50 m depth range of the shelf area. Technologically, nearshore fisheries are tantamount to the municipal fisheries or those utilizing vessels less than 3 gross tons (gt) or no vessels at all.

Important municipal fishing gear are gillnet, hook and line, baby trawl and stationary gear (fish corral, filter net) plus many variations. In 1996, the total catch of the municipal sector reached 700,000 t valued at P25.4 billion (US\$1 billion) (the latter including value of the inland catch). The major species caught are sardines (*tunsoy*), squid (*pusit*), anchovies (*dilis*) and frigate tuna (*tulingan*) but the relative contributions of these species to the total catch only range from 3 to 6%. The municipal fish catch is often underestimated because the number of small-scale fishers who consume or sell fish locally is not recorded.

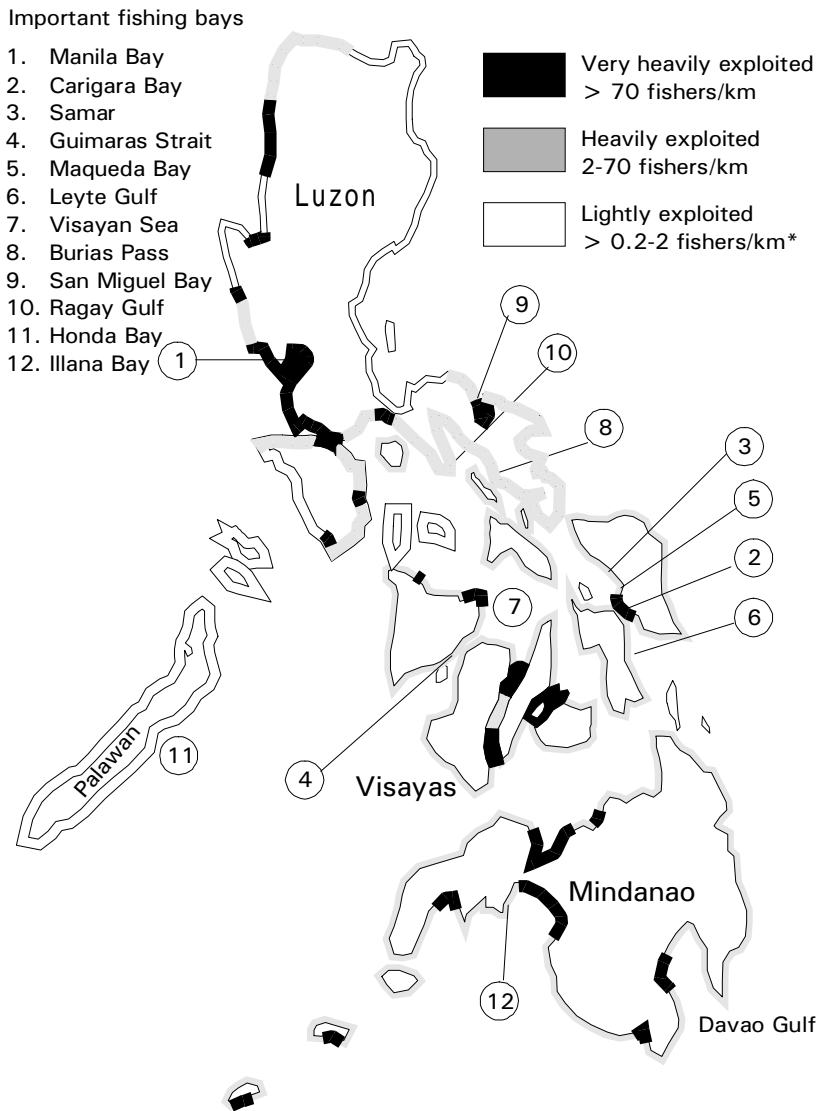
The nearshore area is the most biologically productive area and thus, overexploited (Figure 4.3). Typical trends observed in many nearshore traditional fishing grounds and the types of overfishing as defined in Table 4.2 include:

- A relative increase of cephalopods (squid and cuttlefish) due to reduced predation;
- The disappearance of trevallies (Lactaridae) and sting rays (Dasyatidae) due to recruitment overfishing;
- A relative decrease of snappers (Lutjanidae) and flatfish (Psettodidae) due to growth and recruitment overfishing; and
- A relative increase of “trash” fish due to reduced predation, species replacement, growth overfishing and shifts in the ecological composition of the fishery.

Legally, much of this area, that within 15 km of the shoreline, has been reserved for the use of municipal fishers, by virtue of the Local Government Code. In addition, the Fisheries Code of 1998 reserves up to 10 km of municipal waters for the exclusive use of municipal fishers. Nevertheless, many traditional use conflicts still persist within both the 10 and 15 km limits.

One result of the conflict between the commercial and municipal sectors is decreasing catches. As indicated, the catch from the municipal sector is being overtaken by the catch from the commercial and aquaculture sectors; meanwhile, municipal fishers are growing in number.

Figure 4.3. Map of heavily exploited areas in the Philippines¹⁰⁶.



*The only coastal areas which may not be overfished occur here.

By virtue of both characteristics, it is easy to see that coral reef fisheries are included in this category. Production of coral reef fish of up to 35 t/km²/year is very high by open-water fish yield standards. An added important attribute of this fishery is its huge contribution to the incomes of municipal fishers with very little alternative employment⁹⁵. An estimate of the overall contribution of reef fisheries to the Philippines in Chapter 2 shows that almost 20% of the total fish production of the country could be derived from healthy coral reefs.

Small pelagic and demersal fisheries

Small pelagic fish are a diverse group of marine fishes inhabiting the upper surface layer of the water column, usually above the continental shelf, i.e., in waters not exceeding a depth of 200 m. These fish normally include big-eye scads, mackerels, anchovies, clupeids, halfbeaks and fusiliers³⁷.

Table 4.2. Types of overfishing and their characteristics^{8, 33, 86}.	
Types of overfishing	Characteristics
BIOLOGICAL	
Growth overfishing	<ul style="list-style-type: none"> Occurs when the fish are caught before they have a chance to grow Immature fish below the required age for harvest are gathered
Recruitment overfishing	<ul style="list-style-type: none"> The adult fish population is caught in large numbers so that fish reproduction is gravely impaired
Ecosystem overfishing	<ul style="list-style-type: none"> Happens when the decline in a once abundant fish stock due to fishing is not compensated for by an increase in the stocks of other species
ECONOMIC	
	<ul style="list-style-type: none"> Overcapitalization and oversupply of labor Dissipation of economic rent from excess fishing effort and not levying license fees and market controls Loss of consumer's and producer's surplus as prices go up for consumers and profits decline for producers Depreciation of asset value of the resource

More than 30 types of commercial and municipal gear are used to catch the wide range of pelagic resources. The most important types of commercial gear are purse seine, trawl, bagnet, ringnet and *muro-ami*, which together account for about 98% of the catch with purse seine accounting for 40% of the catch. In the municipal sector, about 40% of the catch comes from gillnets and another 40% from beach seine, bagnet, handline and ringnet. In 1987, average catch rates of municipal gear ranged from 14 to 108 kg/haul consisting mainly of anchovies and sardines. Average catch rates of the commercial sector ranged from 120 to 1,100 kg/haul and species caught were generally higher-priced species, including roundscad and mackerel³⁷.

Demersal fish are bottom-living and dependent on the benthic food chain. They may or may not be associated with coral reefs, have relatively short life spans, high growth rates and high natural mortality implying relative high turnover ratios. Demersal fisheries have been severely impacted by fishing techniques which disturb or destroy the bottom habitat, such as commercial and baby trawls.

WHAT IS LOST AS OVERFISHING INCREASES?

Fisheries scientists have defined overfishing from the biological and economic viewpoints. Biological overfishing may be one of three forms: growth, recruitment and ecosystem overfishing (Table 4.2).

Studies by fishery biologists^{37, 38} on the Philippine small pelagic fishery indicate overfishing. Supporting this is an observed change in species composition, i.e., anchovies have partially replaced sardines, scads and mackerels in the catch, an indication of gradual stock collapse. Furthermore, since anchovies are the cheapest pelagic fish, the absolute value of total catch is beginning to decline. This vicious cycle of overfishing and deterioration of catch quality directly affects the fishers who rely most on fishing for subsistence and income. This situation drives them to fish even more for an ever declining catch.

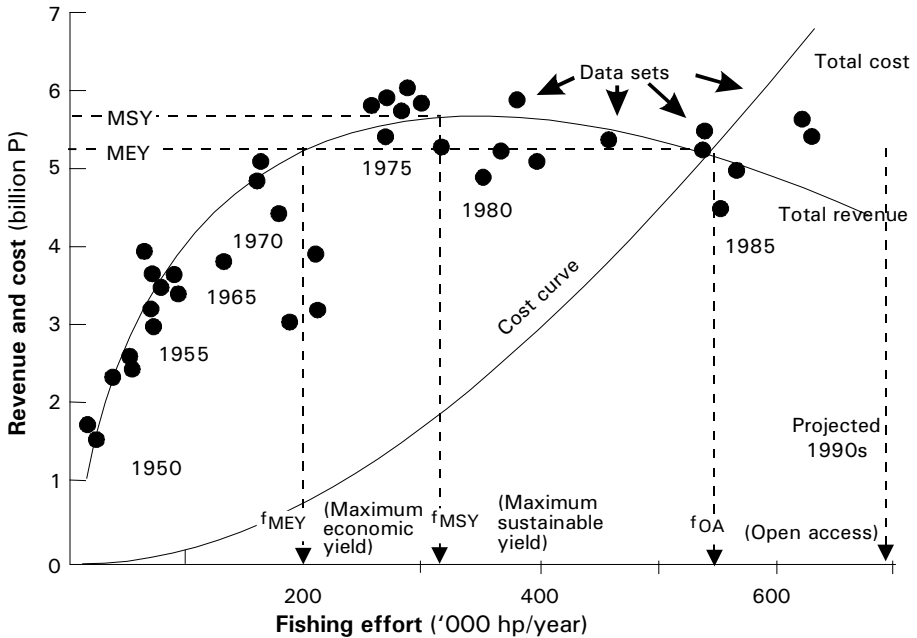
An economic analysis of revenues and costs for the Philippine small pelagic fishery showed similar results: that this fishery is economically overexploited (Figure 4.4). The cost and revenue curves provide benchmarks for management: a) maximum economic yield (MEY); b) maximum sustainable yield (MSY); and c) open-access equilibrium (OAE). MEY is the level of effort which maximizes economic profit. MSY corresponds to a higher level of effort; but where profits are less and fish catch is sustainable through time. Lastly, the OAE level is the point where cost and revenues are equal, profits are zero and catch rates are not sustainable. At this point, there are too many fishers (as measured by fishing effort) so that fish catch (and therefore, profits) are dropping. OAE implies that there is too much labor and capital in the fishery which could have been put to more efficient use in other economic sectors. And, the fish stock is most likely being drawn down below sustainable levels.

An action derived from this analysis suggests that fishing effort should be decreased by 20 to 30% or more in some areas to attain MSY¹¹⁰. By operating at 1985 levels, the estimated annual loss is about P9.4 billion (US\$400 million). In 1998, we are at a point of overfishing more than in 1985. The annual loss could easily be more than US\$0.5 billion.

It is also useful to consider the depreciation of asset value as a result of overfishing. This can be measured using a resource accounting method that considers the resource as natural capital whose value emanates from the stream of benefits capable of being produced over time. An analysis of the Lingayen Gulf fisheries showed that on average, the resource depreciated by P390 (US\$15) million/year from the time that maximum economic yield was reached during the mid-1980s⁸².

Biological and economic overfishing is also evident in the demersal fisheries¹⁰². Demersal fishes are caught by gear which skim the ocean bottom such as trawlers. The MEY level was probably reached in the late 1960s and was equivalent to about 100,000-125,000 t/year or 40% of the actual fishing effort during the 1983-84 study. The authors do not state whether or not OAE has been reached during 1983-84 but relate the possibility of this level of overfishing to other indicators, namely:

Figure 4.4. Revenue and cost functions of the Philippine small pelagic fishery¹¹⁰.



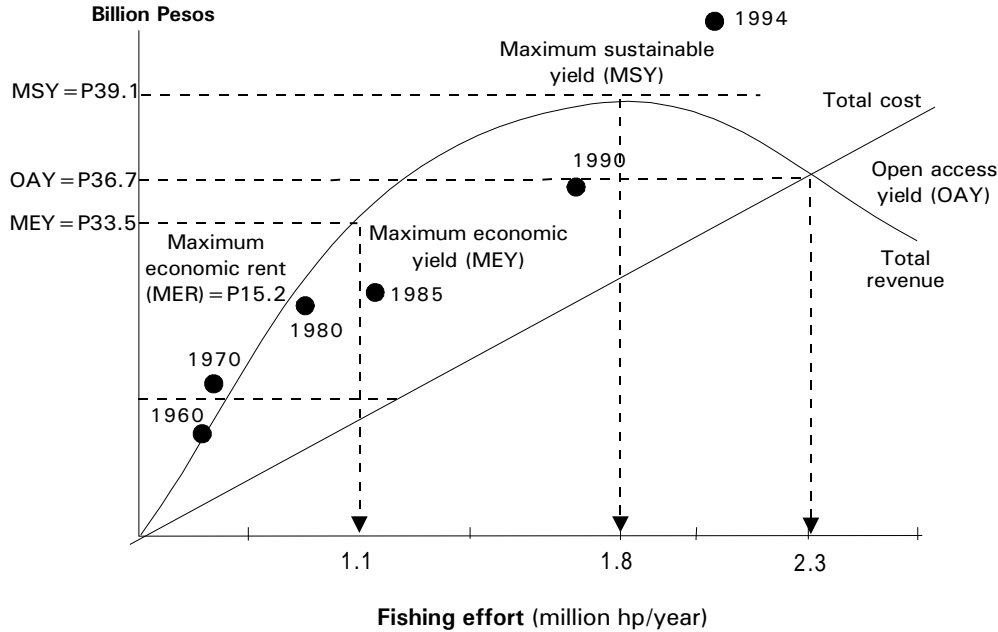
Note: MEY and MSY and the corresponding levels of effort have both been attained in the 1970s. Open-access equilibrium has been reached in the early 1980s. Note the same catch level can be attained at a level of effort corresponding to MEY¹¹⁰.

- majority of fishers are below the “official poverty level”;
- low catches and thus, economic returns from both commercial and municipal sectors; and
- increased competition between commercial and municipal sectors.

In 1996, Israel and Banzon⁶² estimated the economic rent for all commercial fisheries rather than focusing on particular species groups. A biological surplus model was used to establish the relationship between total commercial fisheries catch and horsepower

(including engine and labor power as converted). The analysis yielded MSY levels at 785,706 t corresponding to a fishing effort level equivalent of 1,833,191 hp and a value of P39.1 billion (Figure 4.5). Meanwhile, the maximum economic rent (MER) at MEY and MSY levels are P15.2 billion and P9.7 billion, respectively. In terms of volume of fish production, the MER corresponds to about 306,000 t of fish. It can further be inferred that the MSY was attained in the early 1990s and the MER during the late 1980s. This means that the degree of overfishing has worsened since 1990 with long-term implications which, although not fully known, will mean a decrease in the total fish production for the country.

Figure 4.5. Actual (indicated by dots) and estimated (curves) values of all commercial fish production in relation to fishing effort, 1948-1994⁶².



Note: The estimates also yield three important management parameters: MSY, MEY and OAY. The difference between revenue and cost curves also show potential benefits if the fishery were operating at MEY and the reduction of fishing effort necessary to attain this level which is about 50%.

WHAT IS LOST FROM USING DESTRUCTIVE FISHING METHODS?

Fishing methods destructive to fish population and habitats include use of cyanide, fine mesh nets, drive in techniques using rocks and poles and blast or dynamite fishing. Cyanide-laced fish are a hazard to the health of prospective consumers while the cyanide also kills much invertebrate life in the coral habitat. Blast fishing physically destroys wide areas of reef habitat and the vertebrae structure of fish as well. Despite the ill effects of these methods and the promulgation of national laws to stop them⁴¹, these fishing practices persist.

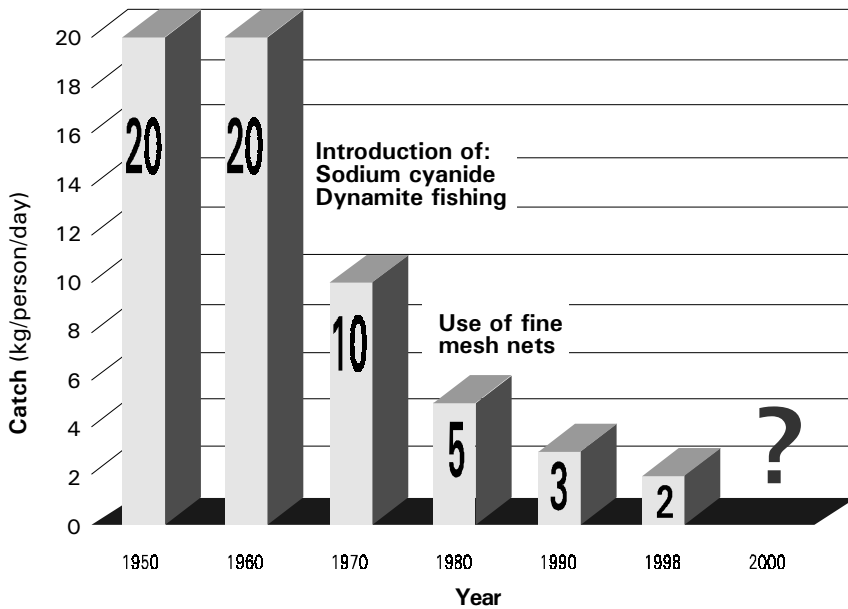
One reason is the “cost-efficiency” of these methods. For example, cost and returns analysis of municipal fishing gear in Lingayen Gulf show the relative efficiency of dynamite fishing compared to other traditional gear (Table 4.3). Moreover, dynamite fishers are known to spend shorter working hours with a maximum of 8 hours at sea compared to bottom set gillnet and dredge net fishers who work 12 hours or more. Thus, short-term financial profitability and labor productivity are relatively higher for dynamite fishers. Of course, the down side of this “efficiency” is that eventually there will be few fish left to catch as shown in Figure 4.6 where for one barangay on Olango Island, Cebu, the catch per person per day has decreased from about 20 kg in 1950 to 2 kg in 1998.

Table 4.3. Total cost, catch volume and net returns per fishing day for selected municipal fishing gear in Lingayen Gulf, Philippines.

Gear type	Average total cost (pesos)	Average total volume (kg)	Net returns (pesos)
Bottom set gillnet	88.2	5.6	-4.1
Baby trawl	148.4	9.0	30.4
Lift net	140.1	15.5	17.9
Dynamite	110.7	10.4	62.6

US\$1 = 20 pesos in 1988

Figure 4.6. Trend of catch per unit effort for one barangay, Olango Island, Cebu, Philippines.



What does the long-term scenario look like? What are the risks associated with dynamite fishing both for the fisher and for the environment? Cases of fishers being maimed or at worse, dying from dynamite-related accidents are rife. Situations such as these decrease, if not totally eradicate, fisher productivity. Simply put, expected net returns would be zero. The greater risk associated with dynamite fishing is destruction to sensitive habitats such as coral reefs. Assuming a conservative decline of 20% in volume of catch, the net returns would drop by more than 70%⁹.

Dynamite fishing indiscriminately destroys not just fish habitats but juveniles as well. Growth overfishing is the resultant problem which is similar to the case when fine mesh nets are used. BFAR estimates a reduction of 10-20% in potential nearshore fish yield when fine mesh nets are used²¹.

By considering the associated risks of dynamite fishing and use of fine mesh nets on human safety and health of the environment, these fishing practices become much inferior to traditional gear. In areas where all destructive methods have been stopped, fish catch using traditional gear have increased markedly.

Impacts of destructive fishing practices on the environment are felt in the long term. The impacts tend to be irreversible with the continued decline in net returns for dynamite or cyanide fishing. Likewise, the need to integrate fisheries management cannot be overemphasized since no amount of enforcement on dynamite fishing will result in overall benefits if fishing effort is, at the same time, not maintained at rational and sustainable levels.

Chapter 5

Water quality: The crucial factor in sustaining marine life

SUSTENANCE TO MARINE LIFE

In the three preceding chapters we have analyzed the trends, condition and economic values of coral reefs, mangroves and fisheries for the Philippines. There is one crucial link binding all of these together and affecting their conditions and economic usefulness to humans. This, of course, is *water*. Water and its transport role is crucial in the maintenance of all coastal ecosystems because these ecosystems and their numerous organisms are dependent on the incubation and movement of larvae which provide new recruits of fish, invertebrates and plants to all coastal systems. Water quality directly affects the viability of these minute living organisms to survive and be successfully transported to their eventual home where they reproduce. Most kinds of pollution are carried by water and affect all living coastal resources and their ability to grow and reproduce naturally. As the sea becomes more polluted, we will lose living coastal resources at an increasing cost to society.

The vulnerability of coral reefs to pollution is well-documented. In Chapter 2, we noted an example from Jakarta Bay where the average depth of coral growth decreased from about 10 to 1 m in the last 70 years as a result of the increasing pollution. Other studies have shown that coral growth rates decrease significantly with increases in phosphates, nitrates, other nutrients, petroleum products, silt and some heavy metals (Table 5.1). Since corals need adequate light, any substance which blocks light will slow their growth rates. In addition, certain chemicals affect their metabolism and ability to grow and reproduce. Many other coral reef organisms follow a similar pattern for corals and are adversely affected by pollution.

Table 5.1. Influence of three water quality parameters factor increases over ambient (normal) for various proportions of coral growth inhibition⁵⁶.

Water quality parameter	% Growth decrease of coral		
	90%	50%	10%
Suspended particulate matter (silt)	x 4.23	x 1.94	x 1.13
Chlorophyll- <i>a</i>	x 4.88	x 2.48	x 1.22
Reactive phosphate concentration	x 2.25	x 1.61	x 1.11

Note that if reactive phosphate concentration increases by 2.25 times normal, coral growth decreases by 90%.

Mangrove plants are less vulnerable to pollution in a general sense than corals. Yet, many of the aquatic organisms which live in or depend on a mangrove system are highly vulnerable to increasing pollutant levels. Crustaceans, an important member of the mangrove food chain, accumulate herbicides and heavy metals which affect both their long-term reproductive capacity and their quality for human consumption.

Marine fisheries are extremely vulnerable to the effects of certain pollutants because of their high metabolism rates and because their larval life cycle exposes them to wide areas of marine waters at a time when they are affected by relatively small quantities of pollutants. Fisheries, the ultimate product we associate with the sea because of their food value, are already under increasing scrutiny for the potential impact of the pollutants they pass on to humans. The obvious case is the increasing incidence of red tides, transmitted through some crustaceans and fish, which can kill humans if the concentrations are high enough. Red tides are increasingly associated with levels of certain pollutants in relatively closed bays or areas without adequate water circulation.

POLLUTION SOURCES AND TRENDS IN COASTAL WATER QUALITY

Marine pollution has been defined as the “anthropogenic input of substances into the marine environment resulting in harm to

marine life, human health, marine activities and a reduction in the quality and usefulness of sea-water³⁴⁹. The types of pollution common in Philippine coastal waters are numerous but there are a few sources which are pervasive and are causing increasing harm to coastal ecosystems and fisheries production^{31, 51, 63, 107}. These are:

- a. Domestic sewage liquid waste with high nutrient loads, some toxic chemicals and biological contaminants from coastal cities and municipalities, and ships, most of which go into the sea;
- b. Domestic solid waste from coastal cities and municipalities, and ships, much of which is dumped into shoreline areas or rivers and ends up in the sea;
- c. Sediments from upland and coastal erosion, construction sites, deforestation, poor agriculture practices which flow through rivers or directly into the sea;
- d. Mine tailings and sediments from quarrying and mining both in the coastal and upland areas, much of which flows to the sea through streams and rivers;
- e. Industrial organic and toxic wastes (heavy metals), which although often treated or restricted, end up being dumped into rivers and eventually the sea;
- f. Agriculture chemicals such nitrates, phosphorous and pesticides which mostly pollute nearby rivers, streams and ground waters, some of which go to the coastal waters;
- g. Aquaculture development which causes increasing acid levels in soil and water and releases nutrients from fertilizers and pesticides into nearby coastal waters; and
- h. Oil and fuel leaks and spills from ships.

Broadly separated, the three categories of pollutants are distinguished by those that are organic in nature, e.g. nutrients and oils; inorganic substances including metals and radionuclides; and

the persistent organic pollutants (POPs) made up of pesticides or herbicides, polyaromatic hydrocarbons, polychlorinated biphenyls and other synthetic organics commonly called plastics. Of these, POPs rank highest both in terms of environmental impact and difficulty of measurement. The organics are more easily detected but are known to have a high impact as shown in Figure 5.1.

About 50% of the coastal and marine pollution in the Philippines comes from runoff and land-based discharges. A sizable, but undetermined amount, comes through the atmosphere from land-based sources. Maritime transportation and dumping may

Figure 5.1. Impact versus difficulty of measurement for contaminants⁵¹.

Impact

Difficulty of measurement

account for about 20% of the pollution if world trends are reflected in the Philippines as shown in Table 5.2.

Table 5.2. Sources of pollution in the marine environment worldwide⁵⁰.

Sources	% of all potential pollutants
Runoff and land-based discharges	44
Atmosphere (largely land-based)	33
Maritime transportation	12
Dumping	10
Offshore production	1

The trends in coastal and marine pollution in the Philippines are not encouraging, with the incidence of pollution-related problems increasing dramatically over 20 years ago. There are more records of ecosystem failure due to pollution in areas close to urban development or areas near human settlements of any size because of domestic waste. Algal blooms are occurring more frequently and causing red tide events that kill or make shellfish and some fish species toxic. Heavy metals are being implicated in fish and human poisoning in some bays where mining occurs or did in the past. We see increasing amounts of plastics on beaches. Endocrine-disrupting chemicals from aquaculture, agriculture and other land-based activities are increasingly being detected in marine sediments. These chemicals can affect the reproduction of certain marine organisms and can be transmitted to humans^{63, 105}. The result of all this will be an increasing drain from societal welfare and economies.

WHAT IS BEING LOST FROM COASTAL AND MARINE WATER POLLUTION?

Pollution in coastal and marine waters has a major impact on estuaries, mangroves, coral reefs, seagrass beds, soft-bottom benthic communities, as well as adjacent waters that support important fisheries. We have shown the vulnerability of these systems to

various kinds of pollutants and cited studies which indicate long-term effects of pollutants on endocrine systems, reproductive health of marine organisms and humans as well as the effects on growth rates of corals and other more physical impacts of pollution. The linkages between lowered productivity of these systems and lowered economic value are not difficult to make. The three major economically valuable resources of most concern that are affected by pollution are fisheries, recreation and tourism industries and biodiversity.

One way to quantify the losses caused by water pollution would be to measure the decline in productivity of the marine ecosystems of concern. The losses to fisheries, tourism, recreation uses and biodiversity as a result of pollution can all be quantified as done in Chapters 2, 3 and 4 from the impacts of habitat destruction for coral reefs and mangroves and overfishing for fisheries. The losses from these economic sectors resulting from pollution will be proportional to the severity of the pollution and size of resource economy affected. If a coral reef is destroyed from urban runoff or fresh water flooding, the losses will be equal to the original productivity of that reef plus whatever other benefits derived from it such as coastal protection. We indicated in Chapter 2 that 1 km² of healthy coral reef can easily generate US\$50,000/year from fishing and tourism. Thus, the cost of pollution destroying such a reef can be equated to this value. Similar computations can be done for mangroves, fisheries and other marine resource systems. The decrease in fish recruitment caused by polluted water could also be measured in reduced productivity.

Another way to quantify the cost of pollution is to value the environment's services as a receptor of waste. The amount that polluters, such as factories, households and others, are willing to pay for discharging wastes into the environment is a direct method of measuring environmental waste disposal services (EWDS). This willingness-to-pay may be the maximum amount that the polluting firm is willing to incur should it be denied the privilege to dispose of its wastes into the environment or the prospective cost of reducing pollution to a non-damaging level¹⁸³.

Lingayen Gulf and its river basins have been studied for EWDS provided as receptors of pollutants. The value of these EWDS in terms of the control costs for the manufacturing sector alone was P9.9 million in 1995⁸³. The average annual value of EWDS by source of pollution from 1986 to 1995 is shown in Table 5.3. The overall average annual value of P366 (US\$14.1 million) of EWDS provided by the Gulf represents what polluters should be willing to pay to prevent the dumping of their wastes. This substantial amount undoubtedly underestimates what is being lost every year in the Gulf in terms of lowered fish catch, reduced aquaculture potential, lowered tourism potential and others. One obvious example of this loss is the reduced interest in diving and swimming in and around the over 60-year old Hundred Islands National Park because of deteriorated water quality.

Table 5.3. Average annual value of environmental waste disposal services by source of pollution in Lingayen Gulf (1986-1995)⁸³.

Source of waste	Value (in US\$'000)	% share
Domestic	3,065	23.0
Agriculture	1,472	10.0
Manufacturing	427	2.7
Mining	5.2	0.04
Non-point sources	9,135	64.0
Total	14,104 (P366 million)	100.0

US\$1 = 28.5 pesos in 1995

An important implication of this analysis is that we note that the largest source and value of pollution is from non-point sources. Non-point sources represent soil erosion from deforestation and poor land use practices, flood waters, general urban runoff and others. These sources are difficult to control and yet have the largest single impact on the Gulf. This realization that pollution is not only costly but emanates from many different sources highlights the need for integrated management approaches in coastal areas. Integrated coastal management is the topic of the next and last chapter of this book.

Chapter 6

The big picture: Can integrated coastal management help?

The variety of problems facing coastal areas and resources necessitates the use of integrated management approaches^{29, 122}. Single issue or sector interventions will always miss important contributing causes to coastal management issues. Thus, the emerging comprehensive management is the only approach. The question is whether we can afford the cost and what are the real benefits of integrated coastal management (ICM). Let us look at the potential gain from ICM based on the various values presented in this book. Once we see how large the potential gains are, it is easier for us to determine how much we should invest in management. First, what do we mean by ICM and what interventions are essential within the framework of ICM.

ICM starts with planning, information collection and analysis. All integrated management must involve the various stakeholders in the planning and implementation phases. The perceived and real issues need to be prioritized and solutions sought which are consistent with environmental, social and political realities. The planning process must be open and participatory in nature so that consensus is the driving force behind implementation.

In the Philippines, interventions which are essential for implementation within ICM plans are:

1. Enforcement of basic laws such as those banning destructive fishing methods and other activities which are blatantly damaging to the coastal environment;
2. Formulation and enforcement of detailed municipal ordinances regarding fisheries management, shoreline development, marine protected areas, reforestation, land use and more; and

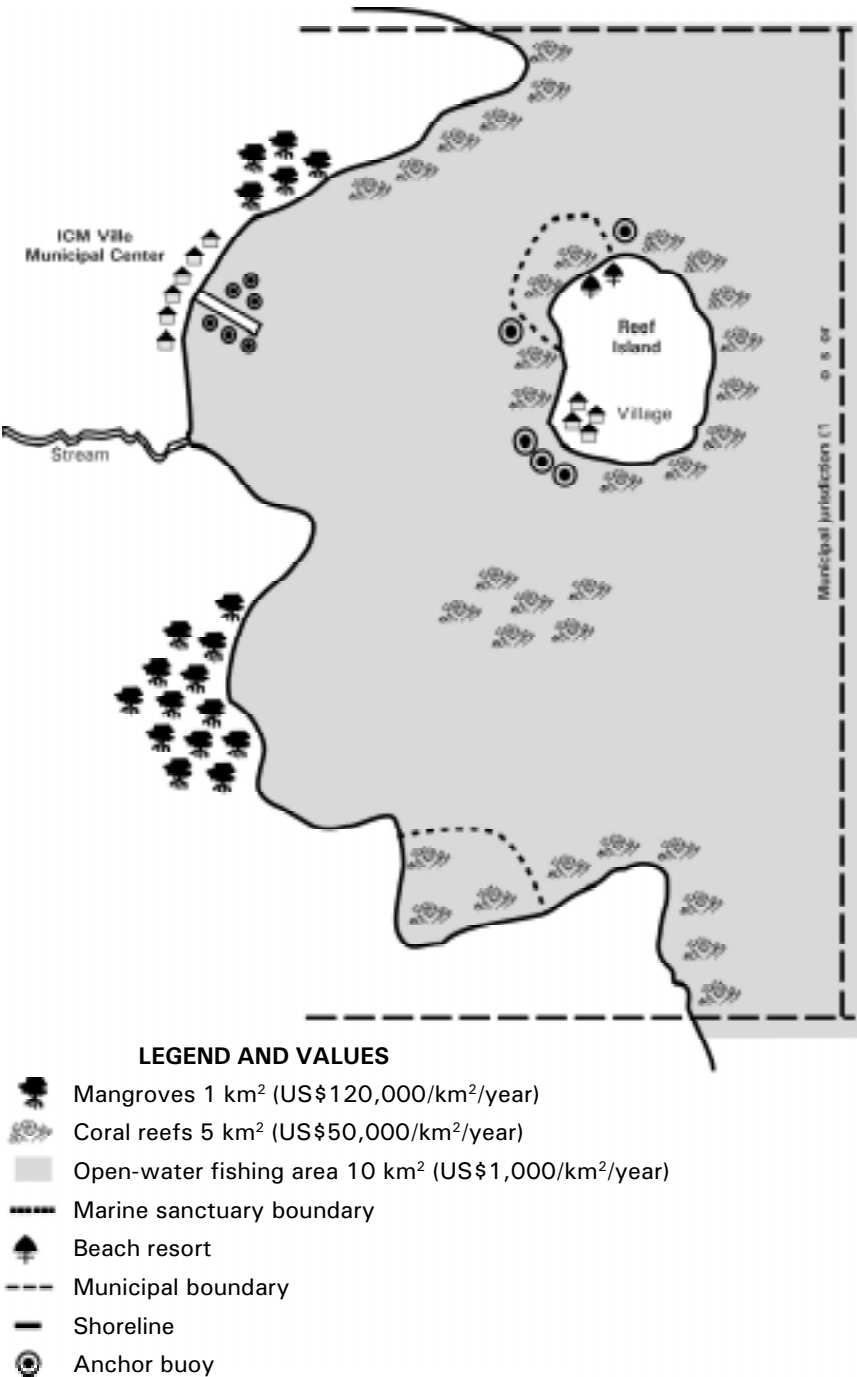
3. Considering varying licensing and economic rent arrangements to control access to coastal resources and to generate revenue for local government units and communities.

Proven models exist for maintaining coral reef productivity for economic benefits from fishing and tourism for small island communities^{30, 119, 121, 129}. These examples all involve the implementation of marine reserves and sanctuaries in various forms. The results of these initial experiments and, now, practical interventions are very encouraging^{96, 122}. It is presumed that much more frequent use of marine reserves in the context of integrated coastal management (ICM) programs will lead to positive ecological and economic development on a wide geographic scale¹¹⁹. Documentation of the status of coral reef condition within marine sanctuaries such as in Mabini, Batangas, since 1990 has shown remarkable improvement due to improved management both inside and outside the sanctuary areas^{118, 120, 125}.

COMPOSITE POTENTIAL GAINS FROM INTEGRATED COASTAL MANAGEMENT

Based on the examples and information in this book, we can now add up the values for the various resources for a typical coastal area assuming a reasonable condition of the coastal resources at stake. A hypothetical bay can be used as an example of the resources and values at stake (Figure 6.1). Our example bay has some coral reef habitat, some mangrove forest and open-water space for marine fisheries. For simplicity purposes we will assume that our bay is still relatively undeveloped and the income of people living in the area is derived from sustainable use of resources in the bay and that they have no other sources of income. The question to be answered is what level of investment in management and protection of these natural resources is warranted given the value of these resources to the local coastal users.

Figure 6.1. Typical coastal municipality and area, its resources, habitats and potential values (Table 6.1 for details).



The values of the resources in this hypothetical bay are summarized in Table 6.1. These values can be compared with the potential cost of management and protection. Based on these resource values, we can justify management costs of less than or equal to the resource values. Of course, in reality, the amount we usually spend on management is only a very small fraction of the resource valuation if the amounts in Table 6.1 are realistic.

Table 6.1. Annual revenues (values) of coastal resources in a hypothetical bay* (shown in Figure 6.1) and the associated costs of management.

ANNUAL REVENUES		
Resources	Area (km²)	Potential annual revenue* ** (in US\$)
Coral reefs	5	250,000
Fisheries		90,000
Tourism		75,000
Shoreline protection		60,000
Biodiversity		25,000
Mangrove forest	1	120,000
Fisheries		50,000
Wood		10,000
Shoreline protection and other contributions***		60,000
Open-water fisheries not dependent on either reefs or mangroves	10	10,000
Total		380,000 (P15.2 million)
ANNUAL COST OF MANAGEMENT		
Staff for community level work (2 persons)		9,000
Training		5,000
Sanctuary maintenance		6,000
Patrol boat and operation		10,000
Information dissemination		2,000
Other		2,000
Total		US\$34,000 (P1.36 million ^a)

^aUS\$1 = 40 pesos in 1998

* Assumes a healthy, natural system without major destructive or polluting influences as shown in Figure 6.1.

** This analysis assumes that all revenues are derived from "management" which means that without management revenues would be significantly less or zero. In reality, management is not responsible for all revenues but only an incremental portion dependent on management efforts that prevent degradation and destruction. But this assumption does not make a large difference in the result since without any management, revenues will eventually approach zero.

*** This figure is a small portion of the estimates by Costanza et al.³⁵ for shoreline protection, recreation and habitat which has not been estimated for Philippine mangroves.

If we take a national perspective and add up the contribution of these basic marine coastal resources to the national economy, we will be impressed with the annual contribution of these systems (Table 6.2). The annual benefits from the existence of our natural coastal resources are conservatively estimated at US\$3.5 billion for the whole Philippines in Table 6.2. Since the national expenditure on management from all sources (government, non-government, donor and others) combined is less than 1% of this amount, we can see that significant increases in spending for protection and management of resources are warranted.

The estimates shown in Table 6.2 are very conservative which means that the annual contribution of these ecosystems together with fisheries to the Philippine national economy is at least US\$3.5 billion every year. It is likely to be much higher in reality since we are not putting economic values on all the ecological functions known to come from coral reefs, mangroves and healthy fisheries. Also, it should be noted that the Philippines has already lost a significant portion of the original value of these systems because of degradation

Table 6.2. Total annual national economic benefits derived from coral reefs, fisheries and mangroves in the Philippines, 1996.

Ecosystem/resource	Area/yield in the Philippines	Value (in US\$)
Coral reefs	27,000 km ²	1.35 billion
Fisheries		
Tourism		
Coastal protection		
Mangroves	140,000 ha	84 million
Fisheries		
Wood*		
Other contributions		
Fisheries	Open marine water	1.25 billion
Municipal (less reef fish)	909,000 t	0.64 billion
Commercial	879,000 t	0.61 billion
Aquaculture	Brackish and marine	0.83 billion
	981,000 t	
Total		US\$3.5 billion (P140.56 billion)

US\$1 = 40 pesos in 1998

*Wood is not included because there is legally little mangrove wood harvesting allowed.

Note: All numbers in this table are derived from information presented earlier in the book.

of the marine environment. Although difficult to estimate, we could safely guess that more than 50% of the natural production of these systems has already been lost. We know this is true for mangroves which have been reduced by 70% since 1920. We know that fisheries are being overfished; thus, the total fish catch is less than its natural potential.

Yet, because the current economic value of these resources is still extremely high by any standard, we can justify investing in their management. Even if we only invested 5% of the national economic rent equivalent of these resources, it would amount to about US\$175 million or more than P7 billion every year. This should be considered as an absolute minimum to ensure some level of management of these natural resources. Unfortunately, the amount invested in management is much less and thus reflects the deteriorating condition of these resources. They warrant more and could benefit from economic policies which tax users and revenue flows so that stewardship is paid for through more sustainable means. Protection of these resources for the future is not free. ICM approaches can begin to lead us in the direction of improved field and economic management policies which may stabilize the condition and natural benefits from our coral reefs, mangroves, fisheries and water quality.

CONCLUSION

We have illustrated the use of economic valuation in planning for and managing our coastal resources and environment in this book. Most of the monetary figures quoted or derived are based on the actual or projected change in productivity of coastal ecosystems and their products. Through this means we are able to see what is being lost from the destruction of coral reefs, mangroves and fisheries and lowered water quality. And we are able to quantify the potential economic gains from management. Other economic valuation methods used are the loss of potential earnings, opportunity cost approaches and contingent valuation or willingness-to-pay. Although we have not analyzed the subtleties of these various methods, it should be clear that economic valuation tools are

essential in forming policies for environment management. As a society, we like to equate our actions to objective criteria. These valuation methods can be used to achieve an economic (monetary) equivalent of value of what we as a society are losing or gaining from our actions.

In Chapter 2, we showed that coral reefs are the most productive ecosystem in the world and provide immense benefits to those who take care of them. When we destroy reefs, we destroy income for various beneficiaries on the order of US\$50,000/km²/year of healthy coral reef. Although this figure varies tremendously depending on the local situation both ecologically and socially, it provides us with ammunition to support the management and conservation of all of our coral reef resources. The potential fish catch alone from a healthy coral reef is enough to justify sizable management costs.

In Chapter 3, we highlighted mangroves as being a very productive ecosystem which is highly threatened in the Philippines. The benefits from mangroves are not as easy to quantify as from coral reefs, but as we learn about their natural ecological roles and their various human beneficial products, we begin to realize that mangroves are a powerhouse resource which needs to be protected and managed. There is really no justification to remove any mangroves and in fact many abandoned and degraded mangrove habitat areas should be brought back to life. The average annual conservative return used for Philippine healthy mangrove forests and habitats is US\$600/ha/year. A simple calculation for all the abandoned fishponds in the country which were once thriving mangroves, will tell us that we can afford to replant mangroves and to maintain their continuous benefits.

In Chapter 4, we looked at the large fishery resources of the Philippines in the context of habitat destruction and overfishing. The sad story for fisheries is that although the country depends heavily on fishing for food, livelihood and export income, fisheries are beginning to decline. There is clear evidence that overfishing or too much effort per unit area and catch is occurring in all the important fisheries of the country. The consequences are that the

overall catch is decreasing and catch per unit effort (person, boat or horsepower) is decreasing and that profits to all concerned are declining. And, because commercial fishing effort with 30% of the catch only employs 6% of the fishing workforce, there is a severe misallocation of capital invested in the commercial fleet which leaves few fish for the small-scale and municipal fishing sectors. Our valuation analysis shows that much more effort and funding needs to be invested in management of fisheries of all kinds. The loss in economic rent of probably more than US\$0.5 billion annually for the small pelagic fishery alone should alert us to the real situation. Total losses are much higher than that if all fisheries are considered. This situation could easily justify support for a much improved fishery management force in the country.

In Chapter 5, we analyzed the importance of coastal water quality in maintaining viable fisheries and habitats such as coral reefs and mangroves. We discovered that increasing pollution of coastal waters will erode our gains in other areas such as destructive fishing and implementation of better fishery management practices. Water quality is the bottom line for all coastal ecosystem health. The losses from pollution will be equal to all the potential benefits from the other systems of concern. One way to measure the potential losses from pollution is to estimate the willingness-to-pay of polluters for losing their ability to dump into the ocean or a river for free. This willingness-to-pay was estimated for the whole of Lingayen Gulf polluters to be approximately P366 million annually. This amount is probably a conservative estimate of what is actually lost in terms of decreased fish catch and lowered tourism appeal in the Gulf.

Finally, in this chapter, we looked at the composite picture for coastal resources in the country and what is required to improve management. Integrated coastal management (ICM) is proposed as an approach which will begin to integrate the needed actions into a more holistic management framework. It is agreed by most concerned policy makers and managers that piecemeal and single sector approaches are no longer viable. The analytical tools discussed are essential for planning watershed management areas which consider threats of pollution, land use and human settlements in general with all their various impacts. An economic analysis helps us

put the various costs and benefits into perspective for realistic plans. The values of coral reefs, mangroves, fisheries and water quality, can be used as driving forces in making arguments to improve the manner in which we develop coastal lands. Most coastal development impacts usually end up in the sea either smothering reefs, replacing mangroves or killing fish through all the channels that link these systems together.

Several conclusions which can be derived from the information in this book for consideration in planning for integrated coastal management are:

- Most ecological benefits of coastal ecosystems can be valued in monetary terms and considered in the valuation of the resource for planning and management;
- It is essential to analyze the actual present and future benefits derived from our coastal resources in terms of both ecological and human-derived benefits;
- The benefits derived from any coastal ecosystem will vary from place to place and in time, thus requiring some basic information about the situation of concern;
- All coastal ecosystems are inherently productive and valuable; and if we do not have the luxury of time to collect basic information on the area and its resources, we should rely on studies from other locations or even countries to provide guidance;
- The natural and real economic benefits from coastal resources in the Philippines have been grossly underestimated, and this has contributed to the massive destruction of coral reefs, mangroves and fisheries in recent years; and
- The cost of effectively managing our coastal resources is generally a small fraction of the annual potential revenues accruing directly from healthy coastal systems.



Highly diverse and productive coral reefs, fast growing mangrove forests, fisheries of many varieties and clean tropical marine waters are the basis of a resource system which has supported coastal communities in the Philippines since people first arrived. Now, these resources are threatened with overexploitation, destruction and pollution. This book helps us value these ecosystems and their products so that we can be better stewards and managers. It is we that must improve our ways and defining value may be the key to this change.



The Coastal Resource Management Project is implemented by the Department of Environment and Natural Resources, supported by the United States Agency for International Development with management and technical support provided by Tetra Tech EM Inc. Address: 5th Floor, Cebu International Finance Corporation Towers, cor. J. Luna and Humabon Streets, North Reclamation Area, Cebu City, Telephone: (032) 232-1821 to 22, 412-0487 to 89, 412-0645, Fax: (032) 232-1825, CRM Hotline: 1-800-1-888-1823, E-mail: prccebu@usc.edu.ph, Website: <http://www.oneocean.org>